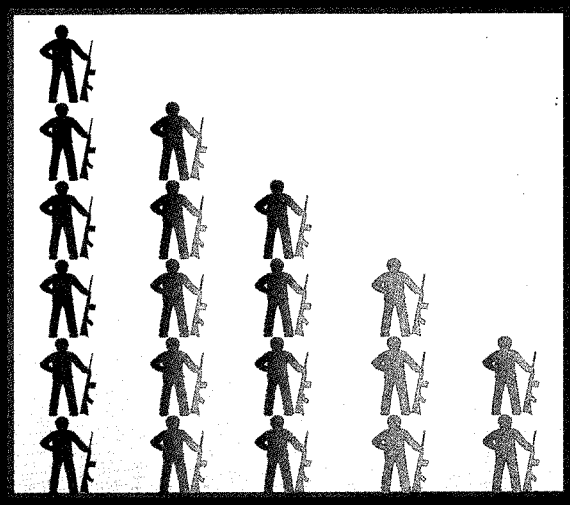
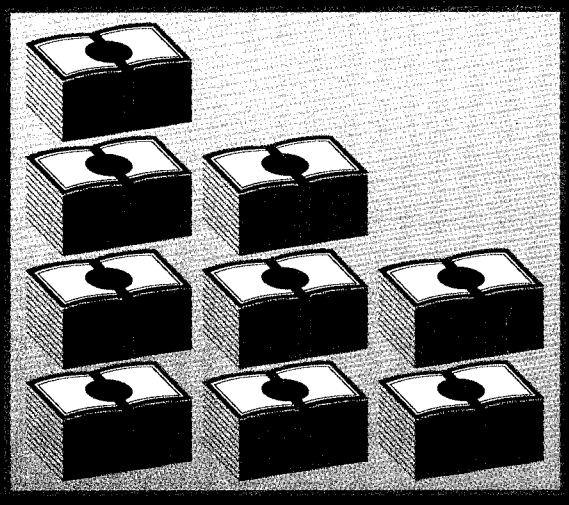
DEFENSE SYSTEMS MANAGEMENT COLLEGE

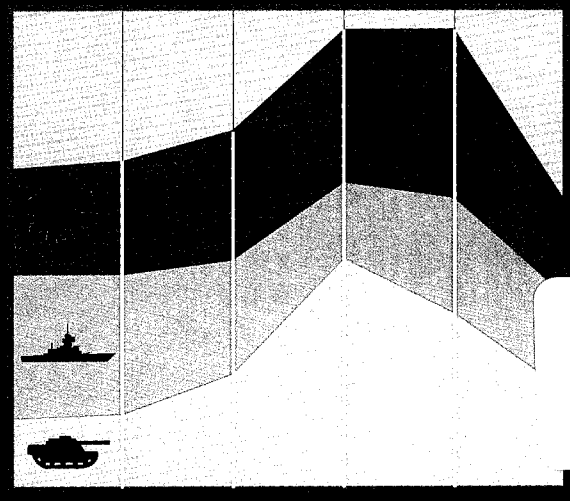
THE EFFECTS OF A SCALE-DOWN IN DEFENSE BUDGETS

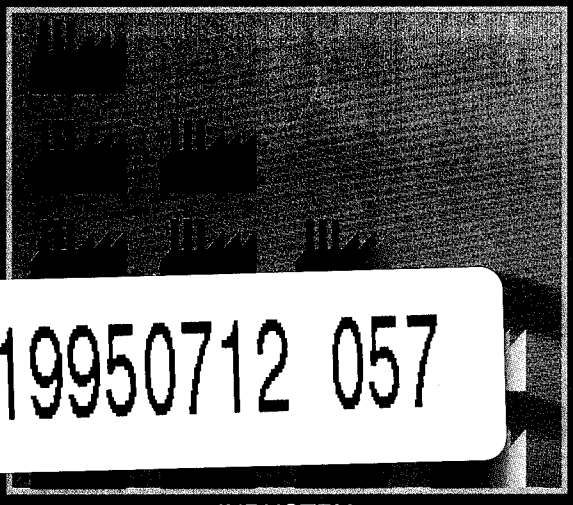
THE KIEL REPORT

VOLUME THREE









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This research effort that has lead to the completion of this report has at its core a number of interrelated goals: 1.) To develop a more comprehensive view of the research methodology or methodologies that might provide better insight into the organization and operations, 2.) Using a specific weapon system as a "test bank", to gain an initial understanding of some of the effects of the continuing reductions in both U.S. and German defense budgets on their respective defense industrial bases, 3.) To determine if the German defense industrial base was more or less "robust" than that of the U.S., and the underlying reasons for these observed differences, and 4.) As a far broader mandate, to develop a better understanding of the organization and operations of the German economy and, in particular, its industrial sector.

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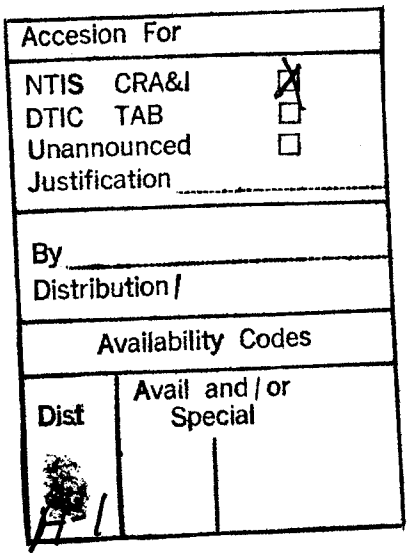

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To Our Readers:

This report can be used as testimony for international cooperation in education and research. The foundation for this cooperation was built in November 1988 with the signing of an International Defense Education Agreement (IDEA) by:

- The Commandant of the Defense Systems Management College (DSMC) - United States (U.S.),

- The Commandant of the Royal Military College of Science (RMCS) - United Kingdom,

- The President of the Federal Academy for Defence Administration and Technology (FADA&T) - Germany, and

- The Delegate General for Armament signed the French Accession Letter in July 1991.

Experiences gained from and opportunities provided by IDEA resulted in a Memorandum of Agreement (MOA) between DSMC and FADA&T in September 1991. This MOA extended the IDEA to include a specific research topic of common interest: the comparable effects of a scale-down of defense budgets in the U.S. and Germany.

Planning meetings between the Commandant, DSMC; the President of FADA&T; and their staffs resulted in decisions to:

- conduct a "pilot-study" to learn what knowledge and data-nodes are needed for the study and the development of a research methodology,
- concentrate on the cultural-economic-legal drivers behind the differences (if any),
- use the U.S. Abrams tank and the German Leopard-2 tank as "comparable objects" for the pilot study to find meaningful comparable data and information, and
- use the U.S. part of the comparative study as the lead part, accepting some time slippage from the original plan.

The DSMC selected Georgetown (GTU) and the FADA&T selected the Institute for World Economy (IWE) at the University of Kiel (Germany) as their study partners.

Ready for action, GTU and IWE reported on data and information research with unrestricted support from the U.S. Army Materiel Command and the German Ministry of Defense. Without this enthusiastic support, the study would have failed.

The results of the joint effort by DSMC, GTU, IWE and FADA&T are documented in the present volume.

My thanks to all who supported this study. I regret that the late Professor David D. Acker who started this project with Professor Franz Frisch cannot enjoy the results.

I recommend this document, not only as a guideline for other comparability studies, but foremost to deepen the mutual understanding among NATO partners. Comments regarding this study may be referred to:

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PREFACE

Introduction

The research effort that has lead to the completion of this report, *The Effects of a Scale-Down in Defense Budgets: Volume III, the Kiel Report*, had at its core a number or interrelated goals:

1. To develop a more comprehensive view of the research methodology or methodologies that might provide better insight into the organization and operations of the defense industrial base, both in the United States (U.S.) and Europe;

2. Using a specific weapon system as a "test bank", to gain an initial understanding of some of the effects of the continuing reductions in both U.S. and German defense budgets on their respective defense industrial bases;

3. Collaterally, to determine if the German defense industrial base was more or less "robust" than that of the U.S., and the underlying reasons for these observed differences. Here the term robust is defined as the ability of an industrial sector to respond efficiently to changing demand factors, in this case a significant reduction in the demand for weapon systems; and

4. Last, and as a far broader mandate, to develop a better understanding of the organization and operations of the German economy and, in particular, its industrial sector.

In order to accomplish this, two research teams were organized and fielded; one, an American group with responsibility for the overall conduct of the research, and the other a German team responsible for the relevant investigation into the German economy and its defense industrial base. The German team was recruited from senior members of the Kiel *Institut für Weltwirtschaft* (The Kiel Institute of World Economics), one of the five government sponsored economic research institutes in the Federal Republic of Germany (FRG). *Volume III: The Kiel Report* reflects the findings of the team that consisted of Drs. Hans H. Glisman, Ernst-Jürgen Horn and Christian Thimann.

Some findings

Many of the findings of this research project were presented in Volume I, which was published in October 1993. At a less global level, recommendations on research methodologies were provided. Basically, the project team proposed that defense industrial sector research be focused around those industrial sectors or processes directly responsible for the development and manufacture of the so-called "force multipliers" that are an inherent part of any effective military system.

On a more global level, it was concluded that the German defense industrial base is potentially more robust than that of the U.S. The basis for this conclusion was an analysis of the information developed by the respective teams in their visits with U.S. and German

defense contractors. As discussed in Volume I, this outcome is the result of significant differences between the two countries in industrial organization, human resource practices, and national institutional structures and traditions.

In order to arrive at these conclusions, the work completed by the German team, and now presented as Volume III, was reviewed and, to a great extent, integrated into Volume I. Specifically Chapter 4 of Volume III, "The Field Visits," is included in its entirety as Chapter 5 of Volume I.

Editorial Matters

The reasons for doing this are quite straightforward. Volume I would not be complete without a report and analysis of the field trips made to German defense contractors. To this extent then, but only to this extent, there are duplications in Volumes I and III.

However, Volume III contains a more detailed description than is otherwise possible in Volume I of various facets of German industrial structure, and the underlying factors creating this structure. Moreover it represents a "German view" of these matters. As such, Volume III is designed to stand on its own.

At the same time, certain editorial liberties have been taken with the output of the *Kielweltwirtschaft* team. First, the numbering and sequencing of the chapters has been changed to reflect the American team's view of its "priorities" for the overall research project.

Second, the report has been edited for linguistic style. German sentence structure is admittedly far more complex than English, quite normally containing at least one or more subordinate clauses per sentence. Because of this, where it appeared necessary, changes were made in sentence structure. In addition, an occasional German word has been translated differently than originally done by the Kiel team. However, in no instance has the content and the meaning of the Kiel work been changed.

Of special concern to the American was maintaining loyalty to the underlying "spirit" of the Kiel report. The reason for this is most important. The Kiel team presents a German view of not only German industrial structure and operations, but also of German economics. It is this uniquely German view that was sought after in the recruitment of the *Kielweltwirtschaft* team. Although it is a truism, it is worthwhile repeating here that Germany is different than the U.S. Indeed, there is much about German industrial structure that is unique.

Preserving this uniqueness has been the guiding decision rule followed by the American team in its editing of the Kiel work.

Volume II

Volume II contains a fuller discussion and analysis of many of the institutional factors that underlie German industrial structure. Specifically, Volume II looked to those elements in

the German economy that promoted the observed efficiency of its industrial base. Here, for example, it needs to be noted that the Germans compete with the U.S. for the number one position in the export market *despite the fact that the German economy is only one-quarter the size* of that of the U.S. It is this outcome among others that drives the need for a fuller understanding of the basis for German industrial success, and the meaning of this success for the future of American industry. To date, much work has been done in the U.S. explaining the "Japanese miracle." Conversely, little is know or discussed about the German miracle. Volume II was designed to shed light on this critical issue as it may affect the future of the U.S. industrial base and, in particular, the U.S. defense industrial base.

EXECUTIVE SUMMARY

In the light of declining defense acquisition budgets in Germany, the purpose of this study was to provide evidence on the resultant industrial downsizing process.

Based on the analysis that follows, it has been concluded that many of the important parameters affecting the adjustment process vary, with firm size being a key determinant of these variations. The large German corporation typically relies only minimally on the defense acquisition process for its sales base and is not significantly affected by the scale-down in the acquisition process. Similar reasoning applies to the small corporation which normally is a subcontractor to the larger firms and specializes in components and parts only. It is only the medium-size corporation which is affected strongly by the reductions in the acquisition portion of the defense budget.

However, in comparison to the United States (U.S.), the scope of the future adjustment problem in the defense industries in Germany will be minimal. Three reasons for this are:

1. The defense share of total sales revenues of German contractors has been traditionally much smaller than that of their U.S. counterparts. In fact, there is no large corporation with a defense share nearly as large as that of the leading U.S. prime contractors.

2. In the case of the Leopard-2 tank, most of the industrial adjustment process has been underway for a minimum of 3- to 5-years and appears to be close to completion. This is the result of the fact that the decline in German government procurements began in the mid-to-late 1980s.

3. German legislation on exports restraints hit the German defense industry and related dual-product businesses especially hard in the mid-to-late 1980s, presaging the need for industrial adjustments of the type called forth by a scale-down in overall defense budgets.

With respect to German industrial organization, the following picture emerged; the German defense-procurement market has been far more cartelized than the U.S. market. This could have been expected due to the relatively small size of the defense market in Germany and the "buy national" practices of most industrial countries, including Germany.

From a broader perspective as discussed at length in Volume II, there are institutional and structural differences between the U.S. and German economies. For example, the labor and capital markets differ substantially, with the German labor market being sector-oriented and heavily unionized. Moreover, in Germany trade unions and employers' organizations, rather than the government, effectively fix minimum wages.

Further, and unlike the U.S., the large banks are an integral part of the cartelization network. Whether these corporate structures alleviate adjustment problems in the defense business or whether a more arms-length relationship would be superior remains an open

question although the evidence presented in Volume II would suggest that the German economy is more flexible in this regard than is that of the U.S. Some of this flexibility is the outcome of the institutional and structural differences noted above.

Executive Overview

Firm-Specific Consequences of the Scale-Down in the Defense Budget; The Case of German Arms Producers as of Fall 1992

Type of Company	Employment per company (average)	Average defense share in sales (%)	Scale-down impact on: Firm structure	Employment	Firm strategy	Economic results
The large corporation*	213,000	4	no	no	no	no
Conversion strategy:	Purely external: • Sale or purchase of firms					
The medium-size corporation**	19,000	47	yes	yes	yes	yes
Conversion strategy:	Internal: • Increase of defense share • Search for new fields of production External: • International cooperation					
The small corporation***	400+	11	no	minor	minor	minor
Conversion strategy:	Internal: • Capacity decline in defense production • Capacity increase in civilian fields of production External: • Arms exports					

* *Daimler-Benz; Siemens; Thyssen; Hoesch; Mannesmann.*

** *Rheinmetall; Krauss-Maffei; Wegmann; MaK; Blohm & Voss; DASA.*

*** *Hoesch Rothe Erde; Clouth; Zahnradfabrik; Behr; Dräger.*

Source: *Kielweltwirtschaft* compilations.

1

AN OVERVIEW OF THE GERMAN DEFENSE INDUSTRY

Identifying the Defense Industry

As in the United States (U.S.), there is no statistical unit in Germany labeled the "defense industry." Instead, defense goods are produced in a variety of industries, the most defense intensive of which is aircraft and aerospace. Defense production's share of this industry's total sales was 35 percent in 1988 (Table 1). Second in defense intensity is shipbuilding with defense acquisitions accounting for 10 percent of its total sales volume. For other industries, defense sales are only a minor portion of total sales. For example, there are about two dozen industries whose total defense-oriented sales are well below 50 million DM per year such that defense sales as a percent of total sales is less than 1 percent. By and large, then, the defense industrial base in Germany is similar to that found in the U.S. [Chakrabarti, Glismann, Horn 1992]. The primary difference between the Federal Republic of Germany (FRG) and the U.S. is in the lack of visibility of German industry and its complete visibility in the U.S. This, we believe, is the outcome of two factors; the more active role of the U.S. stock market, and the larger share of U.S. gross domestic product dedicated to defense procurements.

Therefore, based on the data set out in Table 1, it can be concluded that in all industries at the two-digit Standard Industrial Code (SIC) level the defense procurements provide for only a minor share of industrial demand, although it is surely the most important single customer for many of the industries noted in Table 1. It can and will be argued later that with respect to the conversion problem that only the defense share in total revenues in an industry affects the severity of the restructuring or downsizing process.

Structure and Trends in the Defense Budget

Defense acquisition expenditures in Germany have been declining by some 16 percent per year since 1988 (Table 2). In constant prices the decline was almost 24 percent (from 22.1 billion DM to 16.9 billion DM). In fact, as a percent of total defense expenditures, the decline in acquisition budgets began in 1983 (from 42.4 percent of the defense budget in 1983 to 34.1 percent in 1992). These reductions affected the two most important types of equipment; combat vehicles and aircraft plus missiles. This would suggest then that the need for the affected firms and industries to convert to civilian production is not an entirely new phenomenon. However, it must be considered that "acquisition cycles" may be part of the causes resulting in the figures of Table 2. In addition, since the labor force and the wage bill tend to exhibit significant inertia in Germany, the acquisition

Table I. German Defense Acquisition Expenditures by Industry 1988[a]

Industry	Defense Contracts (Million DM)	Percent of Total Defense Contracts	Defense Share of the Industry[b]
Aircraft and Aerospace	4,295	30.8	34.4
Shipbuilding	678	4.9	10.4
Precision Engineering	334	2.4	1.4
Electrical Engineering and Electronics	2,581	18.5	1.3
Leather Products	116	0.8	1.3
Mechanical Engineering	2,372	17.0	1.2
Clothing	210	1.5	0.8
Textiles	163	1.2	0.4
Road Motor Vehicles	848	6.1	0.3
Fabricated Metal Products	193	1.4	0.3
Office and Data-Processing Machines	54	0.4	0.3
Chemicals	343	2.5	0.2
Others	1,762	12.5	0.3
Total	13,949	100.0	0.8

(a) Acquisition of "*Budesamt für Wehrtechnik und Beschaffung*" (Central Acquisition Agency) only.
(b) As percent of sales.

Source: Berger, et al

budget is the only variable that can be used to adjust a defense budget which fluctuates on political grounds.[1]

[1]Here, it should be noted that the defense budget contains roughly four kinds of expenditures:
- wages plus salaries,
- material inputs,
- maintenance costs, and
- acquisition.

Of these, acquisition is the variable most easily adjusted, if defense outlays are to be reduced.

Table 2. Acquisition Expenditures for Selected Defense Equipment 1978, 1983 and 1992.

	1978		1983		1988		1992[a]	
	Billion DM	Percent of Total Defense Expend.	Billion DM	Percent of Total Defense Expend.	Billion DM	Percent of Total Defense Expend.	Billion DM	Percent of Total Defense Expend.
Passenger Vehicles	0.06	0.2	0.06	0.1	0.08	0.2	0.06	0.1
Trucks	0.59	1.6	0.45	0.9	0.70	1.3	0.36	0.7
Combat Vehicles	2.51	6.8	3.55	7.3	2.87	5.4	2.32	4.5
Aircraft and Missiles	3.35	9.1	6.11	12.6	4.68	8.8	3.86	7.4
Ships and Other Navy Equipment	1.07	2.9	1.26	2.6	1.73	3.3	1.58	3.0
Weapons	0.81	2.2	0.89	1.8	1.59	3.0	1.28	2.5
Ammunition	1.27	3.5	1.84	3.8	2.36	4.4	1.97	3.8
Tools and ABC-Protection	0.10	0.3	0.11	0.2	0.14	0.3	0.06[b]	0.1
Communications Equipment	0.80	2.2	0.84	1.7	1.51	2.8	1.07	2.1
Engineering Corps Equipment	0.11	0.3	0.10	0.2	0.11	0.2	0	0
N.E.S.	3.3	9.0	4.6	9.8	5.5	10.7	5.2[c]	10.0
Total Acquisition								
... at current prices[1]	14.0	38.0	19.1	41.0	21.3	40.4	17.8	34.1
... at prices of 1985	19.3	—	20.9	—	22.1	—	16.9	—

(a) As planned.
(b) The comparable figure for 1988 would be 0.11.
(c) The comparable figure for 1988 would be 5.6.

Source: *Bundeshaushaltsplan* 1992. — Berger *et al* — IMF, International Financial Statistics, current issues; own calculations.

[1] Slight difference due to rounding.

2

THE MAJOR GERMAN DEFENSE FIRMS

The most outstanding recent event in the German defense industry was the creation in 1989 of a "*Systemführer*."[1] In so doing, the Federal Ministry of Economics, along with *Daimler Benz AG* and *Messerschmitt-Bölkow-Blohm GmbH*, moved to establish an institutionally-based competitive edge in military and civilian aircraft, mainly on three grounds. The merger was intended to:

1. Produce system leadership through the *MBB*'s technological know-how, *Daimler*'s managerial know-how and *Daimler*'s connection with the *Deutsche Bank*;

2. Make possible spin-offs from *MBB*'s technology to the other businesses of *Daimler Benz*; and

3. Improve the competitive position *vis-à-vis* the "monopolistic power" of the U.S. aerospace firms, most of all Boeing.

However, the merger did not change the relative position of *Daimler Benz* as one of the top-100 arms-producing companies of OECD and LDC countries (Table 3). Instead it managed to keep *Daimler Benz* from falling back internationally to an otherwise hypothetical 23rd by adding *MBB* to the newly founded *Daimler Benz* subsidiary, *DASA*.

Other German arms-producing firms which did not merge with other companies dropped significantly in rank; e.g., firms such as *Siemens, Diehl, Rheinmetall, Krupp* and *Thyssen Industrie*.

All in all, there were only seven German firms among the top 100 arms-producing firms in 1990. New entries on this list are the shipbuilding companies *Bremer Vulkan* and *Lürssen*. *Mannesmann* is not a true new entry because it simply took over *Krauss-Maffei*.

Not included in the top-100 lists is *Krupp MaK Maschinenbau GmbH*, Kiel, a firm engaged heavily in tank production. Given the size of its military sales, this firm should have been ranked somewhere between 50 and 60 in defense sales.

Some of the top-10 German arms-producing firms depend heavily on defense contracts. *Blohm* and *Voss*, *Wegmann* and *Howaldtswerke* are three such examples. As a matter of fact, these smaller firms are more dependent on arms production than some of the large firms; i.e., *Daimler Benz, Siemens, Mannesmann, Krupp* and *Thyssen*.

It is interesting to note that of the top-100 arms-producing companies, 47 were U.S. companies and 7 were German companies. The international distribution in 1990 was as follows:

---

[1]In this regard, the expression "*systemführer*" is best interpreted as meaning systems integrator as opposed to the more literal translation as "systems leader."

Nationality	Among the Top-10	Top-50	Top-100
U.S.A.	8	28	47
Germany	0	2	7
France	1	8	10
U.K.	1	3	14
Italy	0	3	3
Japan	0	1	6

Quite evidently, this distribution is a direct result of the outcome of World War II, with the winners having not only more arms-producing firms but also showing similar rank patterns. The losers are quantitatively less important in arms production and show similar rank patterns within their group. Whereas defense sales for the three largest defense contractors in the United States (U.S.), McDonnell Douglas, General Dynamics and Lockheed vary between 55-82 percent of total sales, the major defense contractors in Germany, *Daimler Benz* and *Siemens*, had a share of 7.6 percent and 2.5 percent respectively. Dependency on defense sales is greater, as has been stated above, for the smaller defense contractors, but only reaches U.S. standards in the case of the shipbuilding company, *Lürssen*, and then only temporarily.

At first glance for defense contractors, profit as percent of sales appears to be surprisingly low. The highest rates (4.2 percent) was earned by the *Daimler Benz/ DASA* subsidiary, *MTU* and *Telefunken System Technik* (1990) and *SEL* (1988). *Dornier* (1990) and *Krupp* (1988) incurred losses. A direct comparison with the U.S. again indicates a considerable divergence. For example, the average defense firm in the U.S. realized an average return on sales ratio of 5.51 percent in the years 1980 to 1985 [Chakrabarti, Glismann, Horn 1992, p. 181; definitions see Ibid, pp. 179 sq.]. In 1990, McDonnell Douglas, Lockheed and General Dynamics earned a profit rate of 1.9, 3.4 and -5.7 percent respectively. Thus, it is safe to conclude that (1) the average profit-on-sales ratio is higher in the U.S. and (2) volatility and variance of profit-sales ratios are more distinct in the U.S. than in Germany.

A major reason for such divergences may be found in different accounting rules and/or practices. The predominance of conservative accounting principles in Germany may explain the lesser degree of volatility and of variance. In addition, the U.S. accounting principle of consistency does not exist in German accounting practice and this difference can be used to explain the apparently lower rates of revealed profits in Germany (*Universität Kiel* 1986).[2]

Finally, the Stockholm International Peace Research Institute (SIPRI) data underlying Table 3 indicate that, in the U.S., producers of combat aircraft tend to be highly specialized. The opposite is true in Germany, possibly a long-term effect of allied production restrictions. In Germany, firms producing combat ships, electronics and tanks, and other military motor vehicles tend to specialize more than the firms that produce combat aircraft.

Although the individual firms contracting with the German Ministry of Defense exhibit relatively low shares of arms production in total sales, the opposite holds true for another kind of concentration index. The ten largest arms-producing firms in Germany received about 68 percent of all acquisition contracts in 1988 (calculated from Tables 2 and 3). The comparable figure for the U.S. is 35 percent (Aerospace Industries Association 1988). This would

[2]The issue of "hidden reserves" as they are allowed for German accounting and tax procedures is discussed in detail in Volume II.

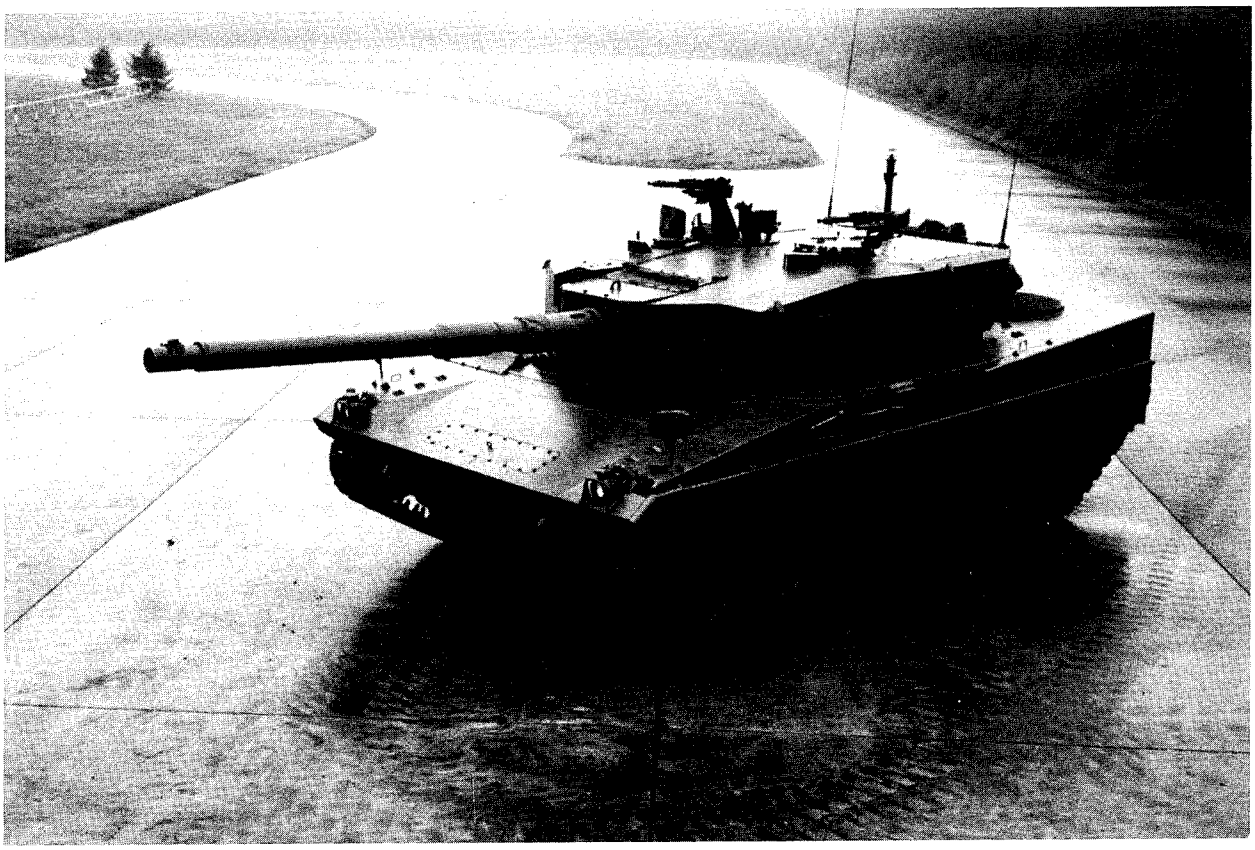
mean that there is a tighter oligopoly in Germany of arms producers than in the U.S. The fact that the Defense Ministry is of a lesser importance for each German producer mirrors the overall lower level of defense expenditures.

Table 3. The Largest Arms-Producing Companies in Germany 1988 and 1990; International Ranking and Performance Indicators

Company	Ranking[a]		Arms Sales[b] Mill. US-$		Local Sales[b] Mill. US-$		Profits[b] Mill. US-$		4 as of 6	5 as of 7	8 as of 6	9 as of 7	Employment (000)		Arms Produced[c]
	1990	1988	1988	1990	1988	1990	1988	1990	1988	1990	1988	1990	1988	1990	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
I.															
Companies of the 1990 Top-100 Ranking															
Daimler Benz	15	15	3420	4020	41851	52918	969	1111	8.2	7.6	2.3	2.1	339	377	Ac: Eng: MV: Sh: Mi.
of which (in 1990)															
DASA (Deutsche Aerospace)	–	–	–	3720	–	7752	–	–84	–	48.0	–	–1.1	–	67	Ac: Eng: El: Mi.
of which															
MBB (Messerschmitt-Bölkov-Blohm)	–	29	1990	1420	4054	2853	56	37	49.1	49.8	1.4	1.3	40	23	Ac: El: Mi.
MTU (Motoren- und Turbinen-Union)[d]	–	–	970	1110	1867	2229	17	93	52.0	49.8	0.9	4.2	17	18	Eng.
Telefunken System Technik[e]	–	–	–	680	–	1045	–	44	–	65.1	–	4.2		9	El.
Dornier[f]	–	–	570	500	1093	1787	23	–23	54.5	28.0	2.2	–1.3	10	11	Ac: El: Mi.
Bremer Vulkan	50	–[g]	–	1050	–	2369	–	22	–	44.3	–	0.9	–	11	Sh: El.
of which															
Systemtechnik Nord	–	–	–	470	–	629	–	–1	–	74.7	–	0.2	–	2	El.
Siemens	52	57	800	990	33823	39107	791	1032	2.4	2.5	2.3	2.6	353	373	El.
Diehl	55	66	610	860	1360	1779	n.a.	n.a.	44.9	48.3	n.a.	n.a.	14	15	A: MV: El: SA/O.
Rheinmetall	59	62	650	750	1850	1838	47	58	35.1	40.8	2.5	3.2	15	14	A: SA/O
Mannesmann	92	–	–	410	–	14819	–	287	–	2.8	–	1.9	–	124	MV.
of which															
Krauss-Maffei[h]	–	91	380	410	723	873	1	14	52.6	47.0	0.1	1.6	5	5	MV.
Lürssen	94	–[i]	–	400	–	495	–	n.a.	–	80.8	–	n.a.	–	1	Sh.
II.															
Companies of the 1988 Top-100 Ranking Not Showing Up the 1990 Ranking															
Krupp	–	65	630	–	8391	–	–115	–	7.5	–	–1.4	–	63	–	MV:El.
of which															
Atlas Elekronik[k]	–	–	460	–	569	–	11	–	80.8	–	1.9	–	4	–	El.
Thyssen Industrie[l]	–	67	600	–	9563	–	211	–	6.3	–	2.2	–	129	–	Mi: MV: Sh.
Standard Elektrik Lorenz (SEL)	–	100	320	–	2286	–	95	–	14.0	–	4.2	–	23		El.
III.															
Companies Not Included in Any Top-100 SIPRI Ranking Since 1988															
	1989[m]:		1989:		1989:				1989:				1989:		
Krupp MaK Maschinenbau GmbH, Kiel	55	–	864	–	1728	–	–	–	50.0	–	–	–	17	–	MV.
Blohm und Voss AG. Hamburg[n]	over 100	–	297	–	618	–	–	–	48.0	–	–	–	6	–	MV: Sh.
Wegmann and Co. GmbH. Kassel	over 100	–	260	–	520	–	–	–	50.0	–	–	–	5	–	MV.
Howaldtswerke-Deutsche Werft AG. Kiel	over 100	–	175	–	585	–	–	–	30.0	–	–	–	6	–	Sh.

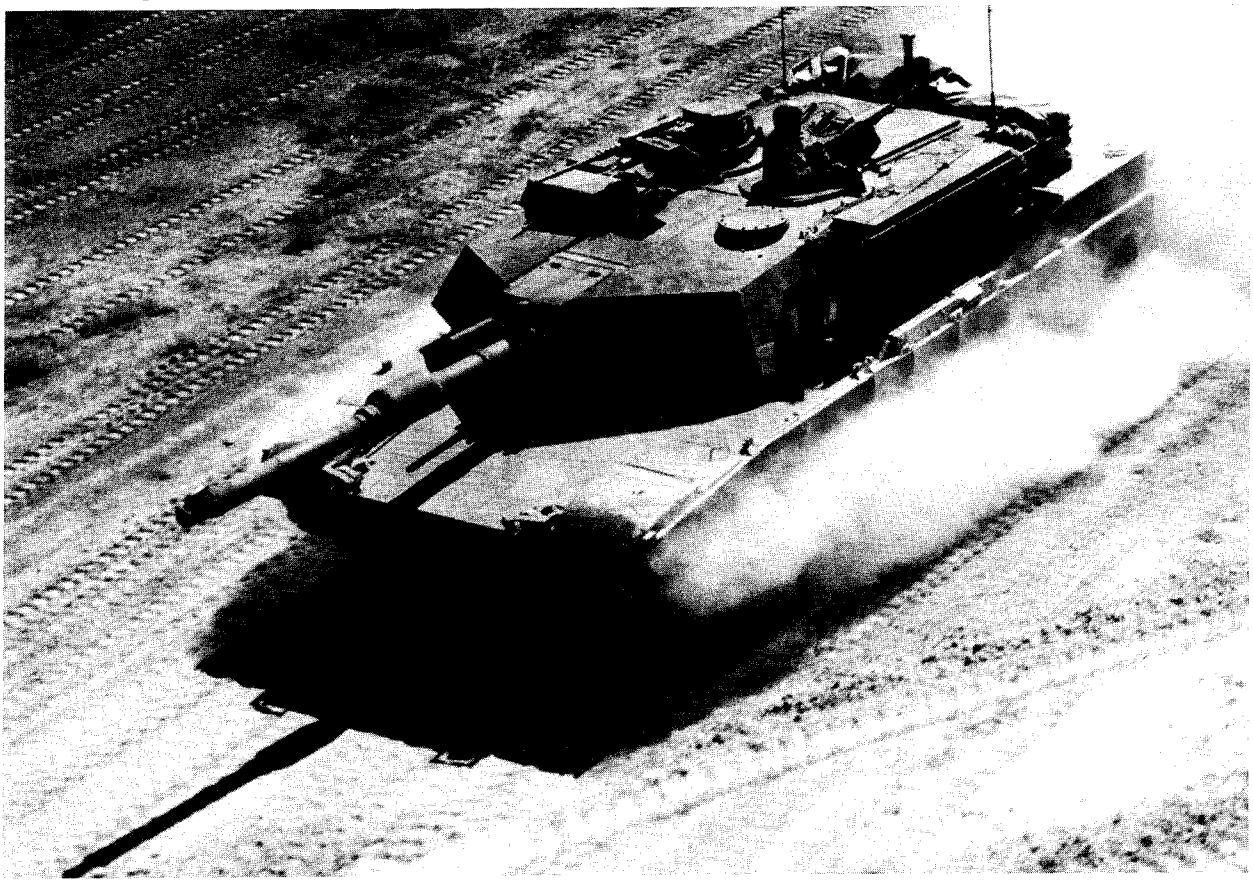
(a) Among the 100 largest arms producers in the OECD and the developing countries. — (b) The exchange rate of the DM changed from 1 US-$ = 1.76 DM in 1988 to 1 US-$ = 1.62 DM in 1990. — (c) A: artillery: AC: aircraft: El: electronics: Eng: engines: Mi: missiles: MV: military vehicles: SA/O: small arms/ordnance: Sh: ships. — (d) In 1988 a direct subsidiary of Daimler Benz (ranked between 49 and 50).- (e) In 1988 a direct subsidiary of AEG and thereby an indirect subsidiary of Daimler Benz (ranked between 40 and 41). — (f) Of. note d (ranked between 72 and 73). — (g) In 1989: rank 133. — (h) In 1988 an independent company. — (i) In 1989: rank 105. — (k) In 1988 ranked between 78 and 79. — (l) In 1988 ranked between 98 and 99; SIPRI does not show consolidated figures for the parent company (Thyssen AG), which would also include Blohm und Voss, and, not shown here, Nordseewerke GmbH, plus Thyssen Henschel. — (m) Hypothetical ranking under the assumption that SIPRI would have included this one company in its 1989 ranking. — (n) Subsidiary of Thyssen AG (of. footnote '1').

Source: SIPRI Yearbooks 1990 and 1992. — Ifo Studien zur Industriewirtschaft 42. — Own compilations.



ABOVE: Leopard Tank

BELOW: M-1A1 Main Battle Tank



3

RESULTS OF THE FIELD RESEARCH ON LEOPARD-2 MANUFACTURERS

Introduction

This section provides empirical data and information on the manufacturers of the German main battle tank, the Leopard-2 The manufacturers consist of one prime contractor, six system manufacturers, and about 20 firms that supply important components and parts.

The original intention of the research staff was to compile most of the information to be presented by means of interviews with all these firms. However, even though the request for cooperation to the firms was accompanied by a cover note from the official *Bundesakademie für Wehrverwaltung und Wehrtechnik, Mannheim,* an affiliate of the German Ministry of Defense, the response was disappointing.

In particular, the prime contractor did not want to cooperate, afraid that information could leak out endangering a possible order from Sweden. Another reason for the refusal to cooperate was that U.S. authorities financed the study. Given the negative experiences encountered by a number of German firms during the Leopard-1 design phase (see Appendix C), German firms are not overly willing to provide information to a U.S.-sponsored analysis. In addition, the prime contractor appears to have recommended to all the subsystem manufacturers that they should not take part in the study. Last, the second-source prime contractor did not cooperate because the firm is in a restructuring and scale-down phase having received additional changes in procurement planning from the German MoD. In such a situation, the firm regarded the provision of information as competitively unwise.

Hence, the information given below on the prime contractor and subsystem manufacturers is derived mainly from evaluations of annual reports, balance sheets and a large amount of very detailed press material, as well as from interviews with renowned independent tank and defense experts. Company interviews were accomplished, however, with the majority of the suppliers of components and important parts. These were personal interviews of about two hours duration with two executives, generally the director of the defense division and a production or sales executive present. (See Chapter 4.)

Empirical Findings

In the following report, the manufacturers of the Leopard-2 are subdivided into two groups, the prime contractor and subsystem manufacturers on the one hand, and the suppliers of components and important parts on the other hand.

The share of total sales contributed by the Leopard-2 is significantly higher for the first group (30-70 percent of defense sales) than for the second group of firms (2-25 percent). The total annual sales attributable to the Leopard-2 program differ greatly between these groups. In absolute terms,

they average DM 300,000 per tank for each of the first group and between DM 10,000 and DM 100,000 for each of the second group, i.e., between about 4-10 percent of the price of one Leopard-2.

Prospects and problems of conversion differ, too. Apart from the quantitative aspect, conversion in the first group includes structural changes in the industry and organizational changes in the individual firms. In the second group, even though there are cases of severe changes, the firms are not affected in any significant way structurally.

Prime Contractor and Subsystem Manufacturers

Krauss-Maffei

Krauss-Maffei, a corporation with 5,000 employees and annual sales of 1.4 billion DM, is the prime contractor for the Leopard-2 tank. The majority ownership position in *Krauss-Maffei* is held by *Mannesmann AG*, one of the largest corporations in Germany (125,000 employees and 24 billion DM sales). Minority ownership positions are held by the *State of Bavaria* and *Diehl GmbH*, one of the Leopard-2s' subsystem manufacturers. The company has undergone substantial change during the past 5 years.

In 1985, for example, the firm had annual sales of 2 billion DM and employed 5,200 people. However, whereas 75 percent of sales were due to defense production, only 25 percent of the labor force worked in the defense division. This is explained by the high share of inputs for tank production bought from other firms with *Krauss-Maffei* doing the final assembly only.

This latter outcome is the result of the German MoD's desire to avoid the development of a highly specialized tank industry or tank manufacturer. As such, it had been the policy of the German Ministry of Defense to keep the value-added component allocated to the prime contractor at as low a level as is technically possible.[1] However, for *Krauss-Maffei*, profits were very large in the defense area and, in fact, covered heavy losses in the civilian section, making overall results in 1985 and 1986 slightly positive with 0.1 million DM in profits earned in both years.

Between 1985 and 1990, defense sales dropped from 1,537 billion DM, on average, or by 15 percent annually, to 669 million DM, or a drop of 57 percent within five years. However, employment effects were by far not that large in the defense section due to the low-value added content of tank production. Because of this, employment decreased only slightly, from 1,250 to 1,100 employees, and to approximately 900 at the end of 1992. Total company sales declined by only 25 percent during this period inasmuch as civilian production (plastics processing and general-processing technology) increased. Dependency on defense declined from a 75 percent sales share in 1985 to only 46.4 percent in 1991. However, from 1988 to 1991, the share of exports in defense sales increased steadily from 23 percent to 40 percent. This will be discussed below as the "substitution-through-exports" effect. However, the ratio of exports will certainly fall drastically in 1992 and after, due to the new export regulations. (See Appendix B.)

Today, the company claims to be pursuing a threefold conversion-oriented strat-

[1]As noted in Volume I, the same value-added outcome has been obtained in the U.S., but more as a result of industrial organization realities than as a definitive outcome of Department of Defense policies.

egy by cutting costs in the civilian sector, enhancing civilian areas of business (in part with new products) and restructuring its organization, i.e., purchasing of companies in related civilian fields of business. However, the military industrial experience gained by the firm in the defense area is expected to be only of a very limited use. Parts of the "know-how" acquired can be used for civilian application, e.g., in the area of simulation technology. The production sites, in particular for tank assembly, however, cannot be converted into civilian production, and only one of the firms's products, transportable road beds, appears to have a dual-use potential.

Wegmann

Wegmann AG, the manufacturer of the turret for the Leopard-2, is pursuing a strategy of rapid diversification into civilian fields. This program includes the expansion of existing civilian product lines, in particular in the field of control and measurement devices, general systems electronics, and automotive-related products. In keeping with its diversification policies, *Wegmann* has purchased a number of smaller firms in related business areas.

As far as its defense markets are concerned, the company is seeking to improve its market position and to respond to potential military requirements. Inasmuch as operating costs are becoming increasingly relevant to the military forces, experienced management "know-how" has become critical. Here, *Wegmann* is seeking to apply for new defense projects as prime contractor using the administrative know-how acquired in managing a critical system for the Leopard-2. Since economizing on fuel requires an expansion of simulation equipment, one of the technological strengths of the firm, the firm is moving aggressivelyinto this market. Finally, since a smaller Army implies less personnel available for in-house maintenance activities, the firm wants to largely take over maintenance services for the *Bundeswehr.*

As a result of these programs, the firm has managed to keep employment fairly constant at 1,800 employees during the last 5 years, although total sales decreased by about 5-10 percent per year, from 780 million DM in 1987 to 610 million DM in 1990.

Rheinmetall and MaK

Rheinmetall and MaK, two subsystem manufacturers, are following a different line of development. Rather than diversifying out of the defense area, they have purchased stakes in other large defense-oriented corporations. One bought a majority stake in one of the most important other subsystem manufacturers in the fall of 1990, claiming that defense technology "has been and will be" its core field of business. Since total procurement volumes are shrinking, the corporation seeks to exploit synergy effects, mainly in the area of armored vehicles, simulation technology, and unmanned vehicles which have dual applications in both defense and environmental protection. Hence, the share of defense sales for these firms may be kept constant at about 40 percent. For 1992, however, sharp cuts in the defense-oriented labor force, approximately 1,000 out of 2,800 employees, are anticipated.

The *Diehl* Company

The *Diehl* Company, a systems manufacturer for the Leopard-2, bought not only a 25 percent stake of the second-source prime contractor but also purchased two large tank factories in Eastern Germany. In doing this, it was responding to a new defense industry requirement, that is, the destruc-

tion of superfluous military equipment, in particular tanks and ammunitions. As a result of this, the share of defense out of total sales (2.38 billion DM, 2.58 billion DM and 2.9 billion DM from 1988-90) remained constant at 45 percent in 1988 and 1989 and even increased to 48 percent in 1990. Employment increased from 14,000 to 15,000 from 1988-90 and declined by only 600 in 1992, a recession year in Germany.

Since 1991, and especially in 1992, this firm has pursued a definitive conversion strategy by moving aggressively into commercial markets and will definitely strive to cut its high dependency on defense sales as rapidly as is possible.

Atlas Elektronik AG

Atlas Elektronik AG is a company with 3,300 employees, 1,600 of whom work in the defense area. Since 1986, the company has been pursuing an active strategy of enhancing its commercial product lines. Management sees the main prerequisites for a successful conversion as a well-specified and credible political planning process for future defense procurement. Given such planning, combined with general political support for conversion, the company claims that conversion will take 4-6 years. In the absence of political planning, the company believes that full conversion will take 8-12 years.

The firm is responding to cuts in the defense budget by enlarging its existing environmental protection markets, e.g., the detection of sea and ground pollution with the help of radar and sonar technology, and electronic guidance systems for traffic flows. The defense divisions now plan to focus their efforts on electronic simulation technologies and applications for robots.

The short-run response to conversion implemented by this company consists of cutting the costs off its commercial products through reductions of overhead and adapting the organizational structure of the firm to its predicted future needs. Long-run consequences are a new direction for its basic research activities as well as a change in the training of the labor force.

Executives are calling for a public-task "environmental protection" program supported and financed by the federal government and claim that the restrictive changes in export legislation are a main obstacle to a successful conversion.

Conclusion

The important aspect of conversion with this group of firms is the change in the structure of the affected firms caused by the scale-down of the procurement budget. Clearly, all firms are reducing their defense activities in absolute as well as in relative terms. But under this rubric, two distinct strategies being pursued.

Some firms have practically "written off" all larger efforts in the defense area. The underlying belief is that there will be no more large procurement of armored vehicles or tanks and that the small projects that may become available fall below the minimum efficiency level of operations (economic scale). They now believe that the defense market in Europe is not large enough to support three main tank-building firms and, hence, it is better to withdraw from defense as far as possible and to minimize all capacities and efforts in this area.

Some firms, in contrast, are trying to focus on the new needs of the armed forces. The underlying belief here is that the Army will undergo substantial qualitative changes, e.g., restructuring toward a rapid deployment force, that will make new equipment

necessary. This will not consist of large main battle tanks, but of smaller armored vehicles that can be air-lifted. Furthermore, electronics is becoming more important and so is a standard chassis for armored vehicles. Here, international cooperation is sought.

In addition, military operations will follow new directions. Reductions in manpower mean less combat personnel, e.g., smaller tank crews, making new technologies such as an autoloader necessary, as well as more maintenance in industry facilities. Even if the cake is shrinking, it will not vanish.

These two strategies are matched on the level of the large corporations in Germany, some of which have been selling and others have been buying shares in the group of prime contractors and system manufacturers involved in the various defense industries.

Suppliers of Components and Critical Parts

This group of suppliers comprises firms located all over the Federal Republic of Germany (FRG), i.e., there is no regional concentration at all. Some of the firms are corporations (*AGs*), some are limited-liability companies (*GmbHs*).[2] Most are affiliates of larger German corporations. Quite a number of firms began as family enterprises, and, in fact, in some of them families still own a substantial part of the shares. Ownership is entirely private in all cases and of German nationality in all but one case. The Federal Government of Germany owns shares in none of the companies, and none of them uses capital supplied by the government.

Moreover, none of the firms is entirely or mainly producing in the defense sector. In fact the share of defense sales is below 25 percent for most of the companies. For some it is even a minor activity, accounting for less than 5 percent of total sales. Furthermore, the share of defense sales is negatively correlated with the size of the firm.

The production of Leopard-2 parts, however, was an important element in the overall defense activities of these firms. Until 1986, the Leopard-2 production accounted for one to two-thirds of total defense sales of many firms and for more than 20 percent of almost all firms. The relative importance of the Leopard-2 production, however, declined sharply in 1987 when procurement of this tank by the *Bundeswehr* and some NATO allies began to slow down. In the period from 1987-1990, the firms engaged in other defense activities, trying to keep the defense sales volume constant. Since 1990 however, most firms have reduced their reliance on defense sales, and can be expected to continue to do so in the future.

The components produced for the Leopard-2 were in almost all cases an in-house development, which generally required special know-how and technology. In addition, the production technology was developed by the companies themselves, with only a small number of firms receiving financial support from the procurement office. Whether or not firms received support often depended upon the firm's policy. Many of them did not apply for support in order to remain owner of the technologies.

[2]An "*AG*" is a corporation whose shares are, or can be, traded publicly whereas, a "*GmbH*" is a privately- owned firm whose shares cannot be offered on the public market. From the perspective of corporate operations, there is little or no difference between these two types of firms both of which can, in U.S. terms, be regarded as corporate entities, i.e., "artificial persons." These issues are discussed at greater length in Volume II, but only in reference to the effect that corporate size, as measured by the number of employees, has on the corporate governance process.

No exact data were provided on R&D expenditures, but firms claimed R&D expenditures to be substantially higher in the military sector than in the commercial sector. Also, the ratio of engineers and technical personnel to total company personnel is clearly higher in the defense-oriented divisions than in their commercial counterparts, in many cases by a factor of two or three. Conversely, special training for the production personnel was required in only a few cases.

Reflecting the "hand-made" or customer-tailored characteristics of Leopard-2 components and parts, the percentage of less-qualified labor in the production-line is lower than in the commercial branches of the firms.

None of the firms intend to increase defense as a percent of total sales, and only few firms seek to keep it fairly constant. Most firms want to reduce the defense share of their total sales substantially. None of the firms want to withdraw entirely from the defense sector. The majority of the firms do not want to close their defense divisions but rather aim at a conversion to commercial applications, with the explicit option of turning to defense again in case the already existing *Bundeswehr* tank procurement plans are realized. For almost all the firms this implies a short-run conversion to their ongoing commercial activities. Only two firms are aiming at opening up new fields of business in the civilian area.

With one or two exceptions, none of the firms finds conversion an easy task. First, because the commercial sector is not booming and, secondly, because using a formerly military, and often more elaborate, production technology creates a cost-disadvantage *vis-à-vis* the civilian sector. Hence, many of them are still hoping for new procurement from the *Bundeswehr*.

As far as personnel is concerned, engineers and technical personnel now employed in the military area often are too highly specialized for the civilian sector and, therefore, only transferable at some cost. On the other hand, layoffs are costly to the firms due to the legally mandated social measures.

For the one or two firms that find conversion poses no problems, two conditions have been met. First, the military product is a spin-off of its fully-developed commercial products lines and hence produced on the commercially oriented production lines and, second, the defense share of total annual sales is less than 2 percent.

4

SIGHT VISITS WITH KEY PRODUCERS

In order to provide more detailed information on the current situation *vis-à-vis* commercialization and/or conversion and on the prospects for future development of the tank industry, interviews were conducted with a number of German firms. The results of these interviews and surveys are presented in the following sections of this report.

To maintain confidentiality, the names of the firms have been excluded from this write-up.

Case 1

General information: This company is an affiliate of one of Germany's largest steel corporations. From 1986 to 1991 the number of employees worldwide remained constant at 6,000, while employment in Germany decreased from about 4,500 to 3,200 people. Total corporate sales were 770 million DM in 1986 and steadily increased to 1.2 billion DM in 1991. In the same period the share of defense sales decreased from 18 percent to 12 percent. The fraction of personnel in the defense sector was 5 percent in 1986 and decreased to a mere 3 percent in 1991.

Importance of Leopard-2 production: Between 1986 and 1991 sales of Leopard-2 parts (turret wire race bearing) fluctuated between 14 and 21 percent of total defense sales. The production technology is very defense specific but not Leopard-2 specific. It stems from a development for the Leopard-1 and has since been used for all defense procurements. Hence, there was neither Leopard-2 specific R&D, nor specific personnel training required.

The prospects for conversion: Since the beginning of 1992, Leopard-2 orders have dropped to zero since there is no spare part or maintenance provision in the current program. The company is trying to keep defense sales constant, at least in nominal terms. Conversion to civilian production is difficult, however, because the defense product and its technology has no civilian use. The production technology and sites could be used for commercial applications, but only at higher costs as they are more elaborate. Also, the "know-how" acquired in defense production has no known commercial application. Since the company cannot easily shut down its production sites, it is pursuing a threefold strategy:

1. Furthering defense exports to NATO countries and to the Far East;

2. Opening up an entirely new field of activity, i.e., space technology; and

3. Conversion into its commercial activities despite the cost disadvantages inherent in producing commercial products on the military-quality production lines.

This last effort, however, requires substantial investment. Given the technological constraints, the firm is seeking first to re-

place orders from the MoD by orders from other governments; second, to replace defense orders with orders from the space sector; and finally, to convert into civilian products where the costs of this conversion are economically feasible.

Case 2

General information: This company is a major factor in the automotive industry with 8,000 employees and 1991 sales of 1.41 billion DM. Defense sales amounted to 11 percent of total sales in 1986 (122 million DM), decreased to 8 percent in 1987 and 1988, when Leopard-2 production slowed down, and increased again to almost 10 percent (135 million DM) in 1990 and 1991, when the company increased its export activities. The new German export legislation that came into effect in 1992, however, has put a severe constraint on defense related exports. As such, defense sales of the firm are expected to drop to 90 million DM in 1992 and 1993, and then decrease even further to 60 million DM, or 4.3 percent of total company sales. The share of personnel in the defense sector is proportional to the share in company sales except that the number of executives per unit of output is relatively high with the number of engineers higher by a factor of three as compared to the civilian divisions of the firm. Conversely, the number of production-line personnel is lower.

Importance of Leopard-2 production: The production of the Leopard-2 "final drive and sub-systems for gearbox" accounted for one-third of all defense sales until 1986, dropped to 15 percent in 1987 from where it declined to 5 percent in 1991. In 1992 and 1993 some spare parts of negligible dollar value will be manufactured. The technology had been produced in-house with financial support from the federal procurement office. The R&D expenditures are claimed to be twice as high in the defense sector as compared to the commercial sector.

Prospects for conversion: Currently, the defense division is engaged in export activities in many Western countries, but facing severe legal constraints. Because of this, it has tried to convert capacities to civilian products. However, of the production sites for defense goods only 70-80 percent can be converted to commercial uses albeit at a cost disadvantage. Additionally, the commercial sector is not now expanding sufficiently enough to absorb the production capabilities of the defense division. It is estimated that only 20 percent of the personnel now in the defense sector can remain in the company, the other 80 percent will have to be laid off over time. Given German social legislation, this will be a costly endeavor for the firm. The real problems are not of the quantitative but rather of the qualitative kind. The engineers and technical personnel working in the defense sector are the most qualified in the firm and are a general source of know-how to the whole company. This part of the workforce, however, cannot be easily kept in the commercial division.

Case 3

General information: The company is one of a number of German subsidiaries of a large U.S. corporation with annual sales in excess of $6 billion. The parent company has sharply cut its defense activities from about 15 percent of its total sales volume in 1988 to about 5 percent in 1991. The German subsidiary that contributed to the Leopard-2 program consists of a defense and a commercial division of approximately 500 to 600 employees each. Total sales in the defense division amounted to 200 million DM in 1987 but

have decreased annually by 10 million DM to 150 million DM in 1992. The defense sales are estimated to drastically drop by 25 percent per year to below 90 million DM by 1994.

Importance of Leopard-2 production: The production of the Leopard-2 components "gyroscopic stabilizer" and related products provided annual sales of about 15 million DM in 1987, which is between 7-8 percent of total defense sales. From 1987 to 1991 these sales declined proportionally to the decrease in all defense sales. From 1992 onwards, however, they will drop to almost zero. All the know-how, intellectual property as well as the production technology came from the U.S. parent, who developed the product. Hence, there was no R&D effort linked to the German production of Leopard-2 components.

Prospects for conversion: Through 1990, the German subsidiary undertook substantial R&D efforts in its defense divisions (roughly 30 million DM), compared to only 1 million DM in its commercial division, in order to stay in business. It provides several components and electronic parts for many tanks and other defense products. In particular, this firm would be involved in one of the two large armored vehicles programs now part of the official German defense plan. However, this program was reduced in projected volume at the beginning of 1992, and it is doubtful whether it will be funded. Given this situation, and the declining volume of defense sales in general, the company plans to reduce its labor force by 100 people per year, i.e., 20-25 percent for at least two or three years. At the same time, it wants to convert its capacities to civilian applications. This is considered to be impossible for roughly half of its defense plants because technologies and products are exclusively defense-specific. For the other half it would be possible only with heavy investments in physical and human capital. The major constraint to conversion facing the defense divisions is the small size of the market for the firm's commercial products.

Case 4

General information: With 1,000 employees, this corporation is a subsidiary of a large German corporation. Total sales for the firm are presently 200 million DM per year. As of 1991, defense sales were 54 million DM. These sales were generated by a 110 person workforce.

Importance of Leopard-2 production: The production of the Leopard-2 components ("ballistic protection" and related equipment) provided for annual sales of 30-35 million DM between 1986 and 1991, and accounted for more than 50 percent of the firm's defense sales, and for 15 percent of its total sales. The product for Leopard-2 was designed in-house, in cooperation with the relevant systems manufacturers. During the main phase of Leopard-2 production (1975 to 1985), about 20 patents were granted; from 1986 on, three patents were granted. No patents were generated by civilian R&D. Between 1986 and 1991, investment in machinery and equipment for Leopard-2 production totaled 4 million DM. In addition, the federal government provided the special means necessary for assembly. Title to this property will remain with the government.

Prospects for conversion: In 1992, Leopard-2 sales dropped by 90 percent, to only 3 million DM for spare parts. From 1993 onwards, defense sales are expected to halve again. The other defense sales are dependent on additional government procurement still being debated in the German MoD, such as the upgrading of the Leop-

ard-2. Since these programs have been postponed, and might eventually be canceled, the company has revised its sales estimates downward by some 20 million DM. The defense sales, and Leopard-2 sales in particular, provided high contribution margins. For example, the 20 million DM downward correction in defense sales include 5 million DM in contributions to corporate overhead. Consequently, the company fears that its overall operating result will become negative. As a first-round effect, almost half of the defense workforce will have to be laid off, but there are also negative employment effects on the company as a whole.

For the other half of the defense workforce, the company is trying to develop commercial substitutes, mainly in the automotive industry (heavy industry vehicles in particular). The production sites can fully utilized, with the production technology used in part for other applications. The product itself, however, has no civilian application.

Case 5

General information: The firm, now one of Germany's largest privately owned (*GmbH*) corporations, began as a small family enterprise at the beginning of the century. With 1991 sales in excess of 1.6 billion DM, it is one of Germany's largest suppliers of automotive components and parts. Until the mid-1980s, defense sales accounted for only 3 percent of total sales volume and have since decreased to less than 2 percent.

The company was restructured in 1990, and all non-automotive-related activities, among them defense, were grouped in a subsidiary. This subsidiary has 1,000 employees, annual sales of 150 million DM, of which approximately 30 million DM are defense-related.

Importance of Leopard-2 production: Production of various forms of cooling devices for the Leopard-2 program accounted for nearly two thirds of all defense sales; 18.6 million DM per year until the mid-1980s. The products for Leopard-2 themselves, as well as the production technology were developed in-house. At the beginning of the 1980s, an entire production facility was constructed for Leopard-2 components. Investment totalled 20 million DM with machinery and other production equipment using 14 of the 20 million DM expended. Between 1986 and 1987, Leopard-2 sales dropped by 50 percent to 9.4 million DM and again to 6.5 million DM in 1990 and 1991. From 1992 onwards they will be zero.

Prospects for conversion: When all special activities of the company were grouped together in a subsidiary in 1989/90, it was planned that the 20 percent defense share should increase or at least be stabilized. However, two years later the defense share had declined to 16 percent with the future trend pointing downward. The defense products, in particular tank-relevant products, have no civilian use. Because of defense-specific requirements, the production facility cannot easily be converted to civilian production. The company estimates that capital costs of between 2 to 5 million DM will be incurred if the facility is converted to commercial use.

Of the general know-how acquired through Leopard-2 production only very fundamental techniques have a positive spin-off for commercial products. Hence, since capacities still exist, the abrupt collapse of Leopard-2 follow-on production, as well as of exports causes three problems in the medium-run. First, defense products are developed, produced and tested "by hand" so that sites and personnel used for defense production cannot be easily converted to

civilian needs. Second, defense contributed substantially to profits (with the official rate of 6 or 7 percent and profit rates in exports being even higher). Third, a non-negligible share of general R&D, in particular basic research, could be booked on defense contracts. Therefore, the company is hoping for follow-up tank programs. If these do not materialize, there are plans to close down the defense capacities entirely.

Case 6

Importance of Leopard-2 production: Sales of suspension-type components for the Leopard 2 accounted for almost 65 percent of all defense sales; 5.5 million DM in 1986. Since then, Leopard-2 sales have fluctuated between 3 million DM and 4 million DM per year with a drop in sales in 1992 to 1.5 million DM. From 1992 on, sales, primarily for spare parts, are estimated to be in the 500,000 DM per range.

Prospects for conversion: The company does not foresee any substantial problems deriving from the scale-down of tank procurements. The Leopard-2 component was developed in-house. However, while R&D in the commercial sector is 5-6 percent of total sales, it is only 1 percent in the defense sector, with no patented spin-offs here. The Leopard-2 component is produced on civilian production lines with technology used both for military and civilian production. Only one processing plant for special steel was installed at a cost of 2.5 million DM in 1984. Hence, conversion poses no problems, and all of the labor force engaged in the defense sector can be absorbed by civilian markets.

Case 7

General information: The company, the majority of which is still held by the founding family, has the business status of a K-corporation. Total sales are estimated to be slightly less than 4 billion DM worldwide. The company has currently 37,000 employees.

The unit discussed here is an integrated division of this corporation, with annual sales of 260 million DM and 2,200 employees. The ratio of defense sales has remained fairly constant at 4 percent over the past five years, and is estimated to decline to 3 percent by 1994.

Importance of Leopard-2 production: The shares of sales of the Leopard-2 components "ball bearings" in all defense sales fluctuated between 33 percent (1986) and 16 percent (1991). It will decline to 5 and then 3 percent in 1992 and 1994, respectively. The component was developed in-house. The number of personnel working entirely in the defense sector is very small; a total of 35, six of whom are engineers. Sales productivity in the defense area is approximately 300,000 DM per employee. While overall profits of the division have fluctuated between 10 and 0 percent from 1986 to 1991, profits in the defense area have remained constant at 5 percent.

Prospects for conversion: The product and the technology has no known civilian application. But since the relative importance of defense sales in general and Leopard-2 components sales in particular is low, conversion poses no problem for this firm.

Case 8

General information: This corporation, a producer of medical products and technologies, has almost 6,000 employees and 1991 sales of 840 million DM. Most of the sales occurred in medical technologies, as well as safety and space technologies. The share of defense is less than 1 percent of total sales with the goods supplied to the armed forces a reverse spin-offs, i.e., a product generated by commercial developments.

Importance of Leopard-2 production: The share of Leopard-2 sales has never been greater than 0.5 percent of total company sales. The Leopard-2 product, though of relatively low cost, is a high-technology product with the firm having a worldwide reputation in this area. Accounting with respect to Leopard-2 business followed the usual routine. The costs claimed by the firm were reimbursed with a 7 percent markup. Auditors regularly checked on the costs. In the main period of procurement the firm employed three or four engineers for R&D as well as for quality control for the equipments supplied. It installed 2 million DM of special production machinery for the Leopard-2 program as well as one workshop. Since 1988, sales from Leopard-2 components declined reaching zero in 1992.

Prospects for conversion: The product and the technology came from the civilian sector. All factors of production can basically be converted to civilian use.

Some Consequences of the Scale-Down of the Defense Acquisition Budget

When the post-World War II decision was made to reconstitute elements of the German defense industrial base, responsible government officials and, in particular, executives of the Federal Procurement Office, found it difficult to get the cooperation and the interest of private-sector firms. Gaining this cooperation was particularly difficult as far as tanks were concerned. Reimbursement of costs plus a guaranteed markup for profits was then one of the major means to overcome the resistance to defense production by the private sector. As time went on, during the Leopard-1 and even more so during the Leopard-2 production phases, firms realized that this was not only a source of stable revenues and incomes, but that production of the tank also enhanced the firm's international reputation. Around 1988/89, when the end of large-scale Leopard-2 procurements by NATO forces was foreseeable, the reaction of *Krauss-Maffei* as well as a number of systems manufacturers was not to step out of defense business, but to apply for funds for upgrading programs as well as other tank-procurement programs. However, the end of the Cold War put an end to many of those endeavors and slowed others. As a consequence, some of the firms increased their exports to NATO allies and other Western countries. This did not necessarily lead to an increase in defense sales but rather was a substitute for the drop in domestic demand. This action, however, has been blocked by German export legislation which came into effect in 1991 and 1992. (See Appendix B). The double effect of the discontinuation of the Leopard-2 program plus the new restrictive export rules on the other hand put an end to clearly definable defense activities. This development, which was characteristic, if not identical, for all of the firms, is depicted in Figure 1.

The small share of defense sales out of total sales was politically desired. Within the defense area, Leopard-2 provided the largest share because it initiated the firms' activities in the defense area. When the demand of Leopard-2 components first declined around 1986/87, they were substituted by other defense activities, often exports. This can be regarded as the first conversion period. In 1989/90, the Leopard-2 program began to expire for many suppliers of components. The gap was again filled by an increase in export activities. In 1991, not only did the Leopard program expire fully, but exports were also cut by export regulations. As a consequence of this, firms involved in the production of the main battle tank have sought to reduce their defense activities as well as their capacities in this field.

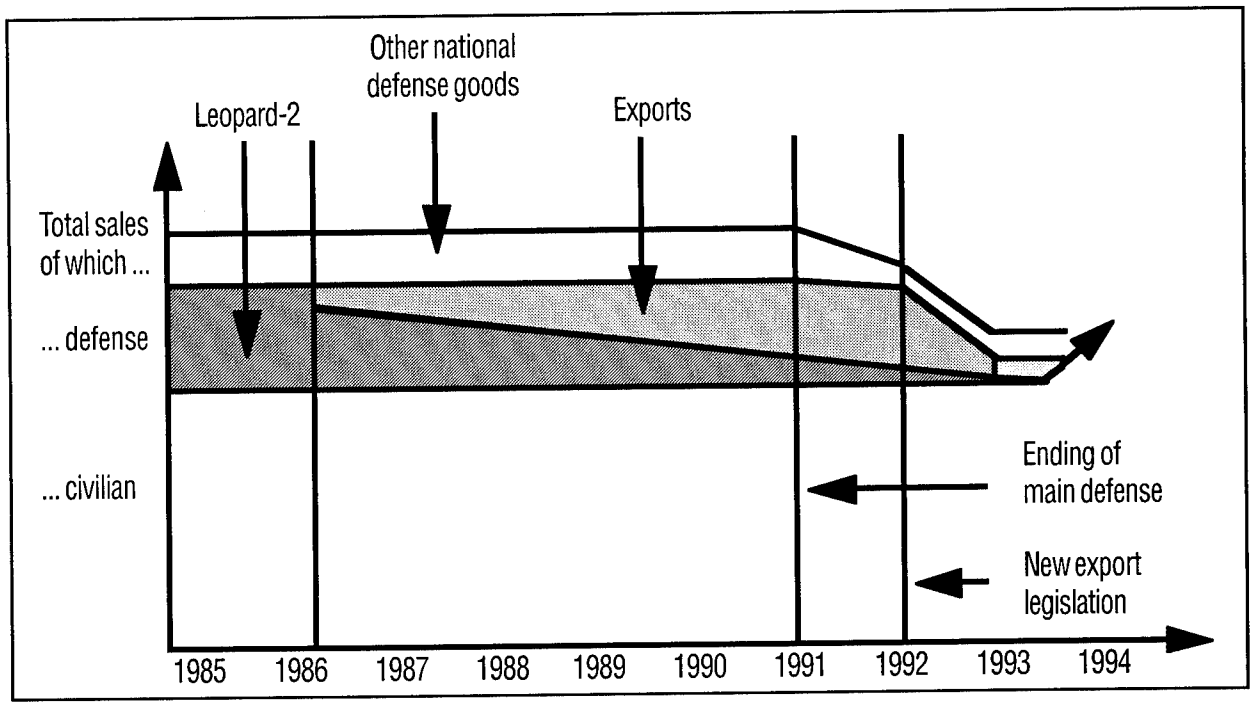


Figure 1. A Simplified Illustration of the Trends of Defense Sales, Leopard-2 and Exports

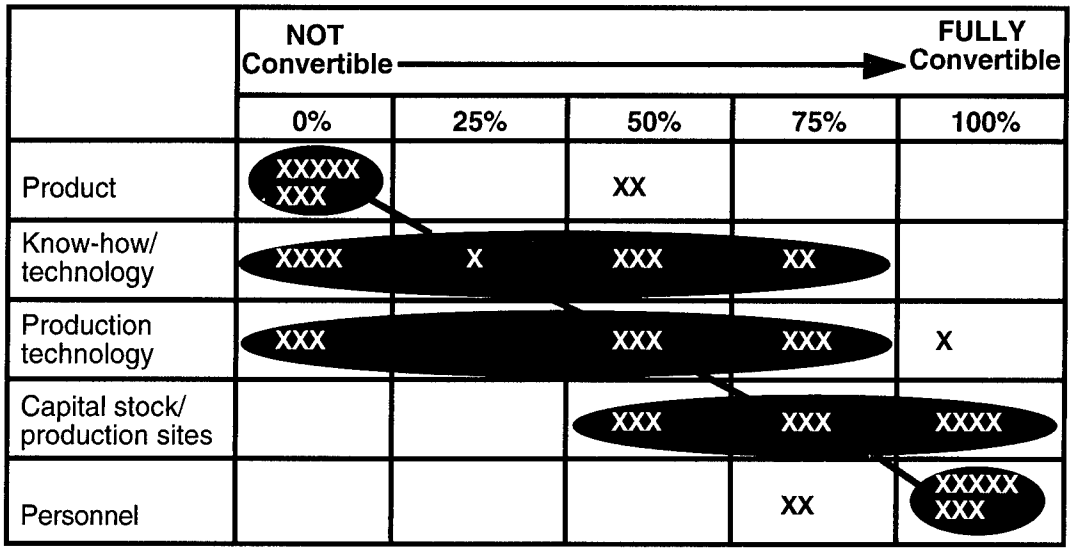
Thus, conversion has two aspects, technological and managerial. The technological (or "internal") aspect of conversion is defined by physical constraints given to a firm by its choice of technology and by its current investment in plant and equipment. It cannot be altered instantaneously or without cost and, therefore, puts a limit on the reaction possibilities of a firm, at least in the short run. The managerial (or "external") aspect refers to the markets open to a firm and thus co-determines the actual outcome of conversion. The following two sections present a picture of the empirical data on the results achieved by firms involved in the Leopard-2 businesses on these two conversion issues.

Technological Factors Affecting Conversion

A substantial portion of the interviews conducted with the firms focused on conversion issues. The technological and physical aspects were subdivided into five categories: Personnel, capital stock/production sites, production technology, general know-how/technology, and the product. Arranged in this order, the degree of technical convertibility is illustrated in Figure 2.

With one exception, none of the firms produces a "dual-use" product. For about half of the firms the basic know-how gained by military production has no civilian use. For many firms the supply of Leopard-2 components demanded a special production technology, including special raw materials, special quality-testing procedures, which in some three cases is not convertible at all. Conversely, in six of the cases partial conversion is possible.

The capital stock can, in general, be used for civilian production. Two of the three companies, claiming a 50 percent convertibility, foresee substantial cost disadvantages when using military production sites for civilian production.



Source: Interviews with 10 firms among the suppliers of components of the Leopard-2.

Figure 2. Extent to Which the Firms Can Use the Diverse Items of Military Production for Civilian Application

As far as personnel is concerned there are almost no constraints to a transfer of these personnel to commercial use.

Actual Conversion

This section presents a summary of the firms' plans for conversion, and their reaction to the scale-down of defense budgets. In Figure 3, the right-hand side represents the difficult aspects of conversion.

It can be seen that most of the firms produced the components of the Leopard-2 on highly specialized production lines. In only two cases was the military good manufactured in a commercial facility (first row). Military capacities are not fully used at the moment, and personnel have to fear layoffs (rows two and three). However, conversion is planned mainly into existing fields of business, usually into a field that is close to the core competence of the firm. Only one firm is seeking to enter a new field of business. Quite obviously, the survey has taken place in a key phase of change in the firms, i.e., in the summer and fall of 1992. When the interviews were conducted, the final part of the new export legislation had just come into effect. Hence, blocking one kind of substitution (exports) is quite new with its final effect on the German defense industry not yet known.

Therefore, in spite of the fact that all firms are fully aware that defense capacities can no longer be sustained at their prior levels and that conversion programs have to be enacted, full conversion has been undertaken by only a minority of three firms (row five). For the greater number of the firms full conversion is not yet concluded. In addition, most firms find conversion difficult because of constraints imposed by relevant commercial markets not expanding quickly enough to fully absorb formerly military capacities.

Has Conversion Been Successful?

Conversion is definitely taking place in all firms. Firms have been implementing strategies for strengthening their non-military sales since 1985, with many of them, however, maintaining some defense capacities.

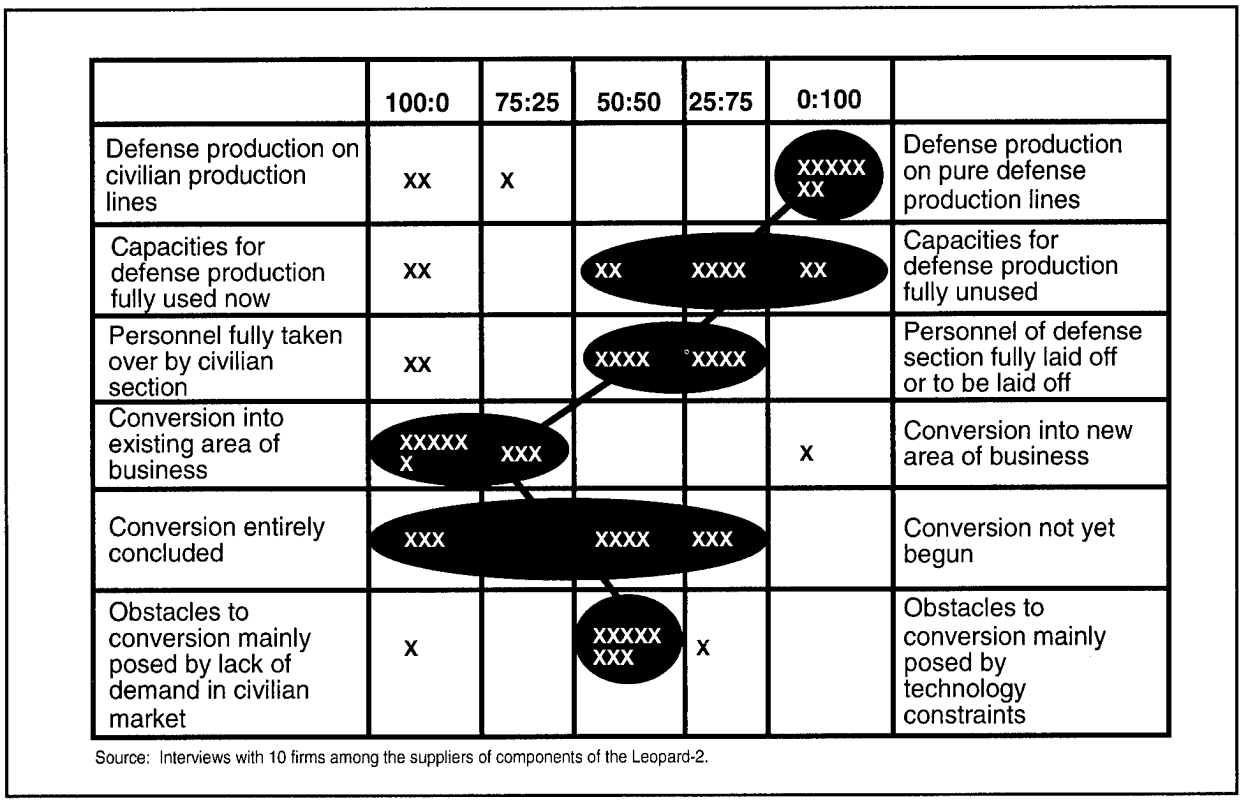


Figure 3. Actual Adjustment and Adjustment Plans among the Suppliers of Components to the Leopard-2.

Since 1991/92, the efforts toward closure of the defense area have been reinforced with specific planning for the defense division halted. In contrast to the group of system manufacturers of the Leopard-2, this does not imply structural changes within the firms, nor a new orientation of the firms' activities.

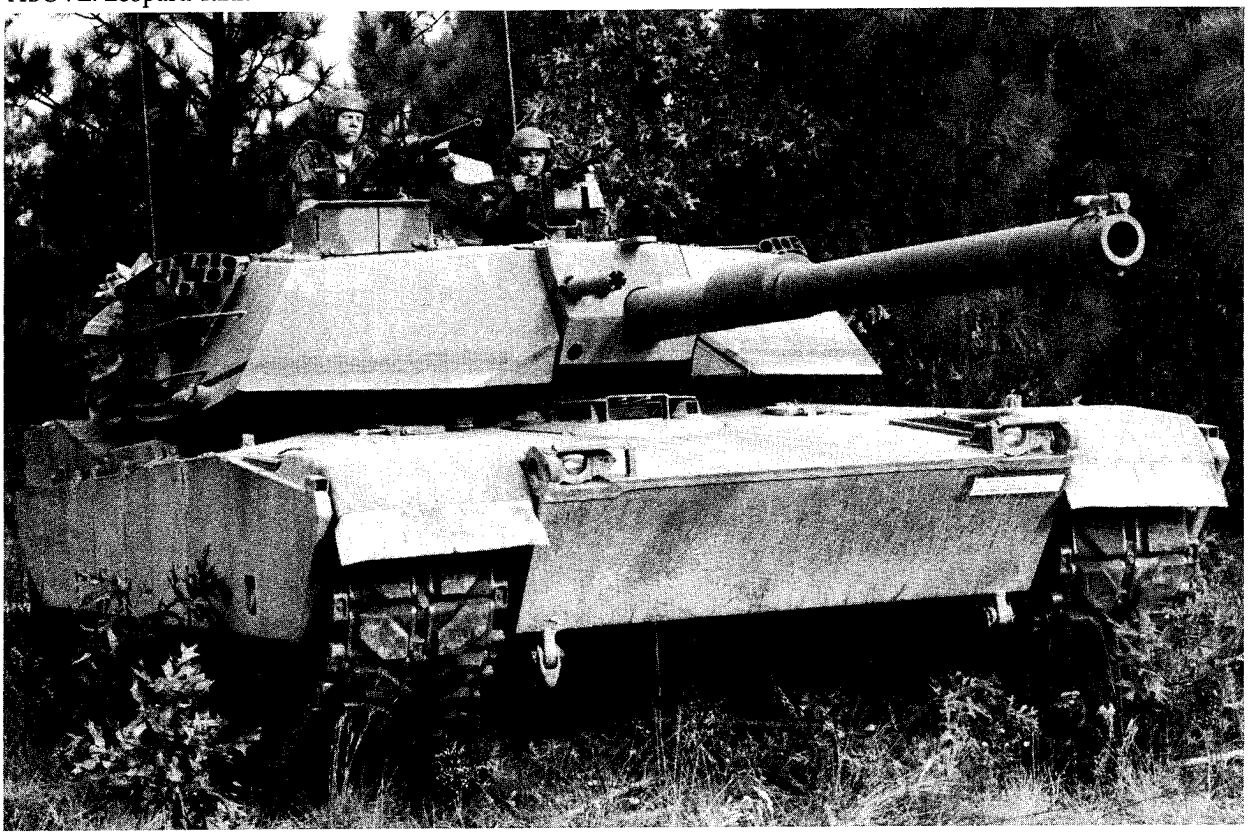
Two firms interviewed have successfully converted. They had it easy because they are the firms that had produced the military good on commercial production lines, with know-how, physical and human capital stemming from civilian production. For these two firms the defense activity clearly had been a side activity.

Then there is a large group of partially successful firms. Conversion generally is possible and has begun, but cuts in sales, R&D and employment in the defense division are necessary. The production factors cannot easily be absorbed or taken over by other civilian divisions. Furthermore, there are technological as well as market constraints that impede an easy conversion of activities. Cuts in employment in the defense section vary between 30-100 percent, which is about 5-10 percent of overall employment, depending on the relative size of the defense section. However, as mentioned above, it is rather the qualitative than the quantitative aspect of cuts in employment, sales and R&D that creates the adjustment problems.

The third group consists of two firms that face a clear deterioration of overall operating results due to cuts in the defense budget. In particular, entry into relevant commercial markets is difficult because the firms are trying to move into a market for products which lack the required experience and reputation.

ABOVE: Leopard Tank

BELOW: M-1A1 Main Battle Tank



5

GERMAN INDUSTRIAL ORGANIZATION

Introduction

With respect to the conversion issue, not only economic variables such as the level of income, exchange rates, cost structures, changes in productivity, the imaginative power of entrepreneurs, or international competitiveness matter, but also the institutional environment. Indeed, as is the case in other countries, defense procurement has been one of the centerpieces of German industrial policy. Consequently, conversion may turn out to serve as a substitute for defense procurement as a way of influencing future industrial structures.

The institutional condition of the German economy, compared to the United States (U.S.), was unfavorable after World War II. About 100,000 German foreign patents (status of 1939) became free goods for foreign competitors. In addition, between 1945 and 1950, industrial production was reduced artificially by prohibitions and quantitative restrictions. All this gave German suppliers a significant competitive disadvantage on world markets for industrial products.

Although the production restrictions were ameliorated in 1949 in the course of the "Washington Industrial Agreement," important industrial sectors such as electronics, vehicle production, and shipbuilding were not liberalized. The technological potential of German industry was reduced additionally by migration of scientists from Germany to the U.S., the United Kingdom and the USSR. These disadvantages in many industrial sectors were offset partly by the funding provided by the Marshall-Plan (1948-1952). But, since at the same time the Marshall-Plan funds were paid out, the destruction of industrial goods went on, and also, since the Marshall-Plan funds did not amount to more than 1.2 percent of the social products of the years of 1948 to 1952, it may be argued that, all in all, a considerable, but not quantifiable net transfer of technologies and capital took place from Germany into the U.S. and other countries.

Such institutional frictions are not the regular historical pattern. Of greater importance are those influences which come from national policies and from the legal conditions set by governments. Among these are the educational system, the rules and regulations underlying the capital labor markets, competition policy, and the stance on foreign trade, especially on arms exports.

Anti-Cartel Policy

We have to differentiate in all 12 EC (European Communities, comprising EEC, ECSC and EAEC) countries between national laws concerning restrictive business practices and EC law. Generally, in case of conflicting national and EC law, the latter is applied. Until recently, conflicts were possible in the field of anti-Cartel laws but not in laws designed to control merger activities because the EC did not have any merger regulation.

With respect to the cartelization issue the most remarkable divergences between EC law and German law are the following:

1. The EC law is, at first glance, tighter regarding restrictions of competition by firms. As a matter of fact, both laws came into force in January 1958. Whereas the German *"Gesetz gegen Wettbewerbsbeschränkungen" (GWB)* declares such contracts among firms or their associations illegal that may affect production markets (§ 1), the EEC Treaty prohibits all agreements and all concerted actions among firms and their associations (Article 85); and[1]

2. At second glance, both provisions are modified after the principle statement to a certain extent, although this is done entirely differently in both legal environments. In the German *GWB*, paragraphs 2 to 9, pursuant to the prohibition of Cartels, allow certain types of agreements, starting with general business conditions (§ 2), and ending with export Cartels (§ 6), import Cartels (§ 7), and the so-called "ministerial permission" (*Ministererlaubnis*) of § 8. The latter was to gain importance later on in the context of the merger of arms-producing firms in 1989.

The EEC treaty provides for a general escape clause instead of enumerating explicitly the exemptions. This clause is contained in paragraph 3 of Article 85, stating that Article 85 paragraph 1 is inapplicable, *inter alia*, in case technical or economic progress is promoted by Cartels, and consumers get their "fair share" of the bargain.[2]

Both legal frameworks enumerate, in addition, certain sectors which are deemed to deserve preferential treatment with respect to competition. In German law the

[1](1) Agreements made for the common purpose by enterprises or associations of enterprises and decisions of associations of enterprises shall be of no effect, insofar as they are likely to influence, by restraining competition, production or market conditions with respect to trade in goods or commercial services. This shall apply only as this act does not provide otherwise.

(2) The term "decisions of associations of enterprises" shall include decisions of meetings of the members of a legal entity, insofar as such members are enterprises. (Section 1, *Act Against Restraint of Competition*).

European Economic Community pact, signed in 1957.

"1. The following shall be prohibited as incompatible with the common market: all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market, and in particular those which:

(a) directly or indirectly fix purchase or selling prices or any other trading condition,

(b) limit or control production, markets, technical development or investment,

(c) share markets or sources of supply,

(d) apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage,

(e) make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts.

2. Any agreements or decisions prohibited pursuant to this Article shall be automatically void." (*Article 85, paragraph 1 and 2, EEC treaty).*

[2] "The provisions of paragraph 1 may, however, be declared inapplicable in the case of:

- any agreement or category of agreements between undertakings;
- any decisions or categories of decisions by associations or undertakings;
- any concerted practice or practices;

which contribute to improving the production or distribution of goods or to promoting technical or economic progress,

following sectors are exempted from the *GWB*: Federal Post Office; and the transport sector (§ 99); agriculture (§ 100); producers of liquors (§ 101); banking and insurance companies (§ 102); utilities (§ 103).

Agriculture and transport receive special treatment in the EEC Treaty as does coal and steel production (dealt with in the ECSC Treaty),[3] and the civilian uses of nuclear energy dealt with in the European Atomic Energy Community pact, signed in 1957. "Special treatment" refers to the fact that these markets have been under continuous and direct regulation of the Communities ever since.

In addition, divergences may have developed regarding the application of anti-Cartel regulations. Today, it is said that the Federal Cartel Office (*Bundeskartellamt*), FCO, has tried to enforce the idea of competitive markets, though not always successfully. The EC has no such Cartel Office. Instead, the Commission deals in its Directorate General IV with cartelization issues. From the yearly reports which are published by both institutions, no divergence regarding the general stance toward pursuing Cartels can be deduced. Divergences are manifest, however, in the process of jurisdictional supervision regarding the decisions of the Cartel authorities. In Germany, it is possible to revise lower-court decisions, whereas in the EC, there is the European Court of Justice only as the final judicial resort.[4] After that date, one additional first-instance court was established for all kinds of trials by the Single European Act of 1987.

It should be noted at this point that rules and regulations of the EC are more complex to adhere to and to apply than national laws, the reason being the diversity of national interests, habits and attitudes. For example, the ECSC Treaty, as well as the two other EC treaties, claim that "...subsidies or aids granted by States...in any form whatsoever...are recognized as incompatible with the common market for coal and steel and shall accordingly be abolished and prohibited within the Community...." (Article 4 ECSC). This provision of 1951 has been "overruled" by the actual policy of the High Authority (later the Commission), which made the coal and steel markets the first prototype of subsidization.[5]

Anti-Merger Policy

The provisions with regard to mergers have been enforced repeatedly in Germany. However, they were introduced into the EC framework of regulations only in 1990. Both developments indicate that corporate mergers have only recently come to be regarded as potential threats to competitive markets.

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while allowing consumers a fair share of the resulting benefits, which does not:

- impose on the undertakings concerned restrictions which are not indispensable to the attainment of of these objectives;
- afford such undertakings the possibility of eliminating competition in respect of a substantial part of the product in question."

(*Article 85, paragraph 1, EEC Treaty*).

[3] The treaty of the European Community of Steel and Coal, signed in 1951, is still an organizational framework of its own, although it has been part of the EC since 1968.

[4] The American equivalent of a "first-court" would be any lower court with initial jurisdiction over a specific legal matter.

[5] Articles 92 and 93 of the EEC Treaty provide for exemptions from the non-subsidization rule seven years later, covering virtually all possibilities of sectoral, regional and firm-specific state aid. In practice, horse trading, pork barrelling and log rolling over the patterns of eligible subsidies under the Community's supervision is a common phenomenon.

Today, German and EC law make mergers dependent on governmental permission, where merging would imply the creation or perpetuation of a dominant market position.

1. In Germany, market share was originally the main criterion. When it reached 20 percent or more, permission was required. Alternatively, size criteria came into play (10,000 employees, or 500 million DM in sales, or 1 billion DM in assets).

   The German anti-merger regulation has been subject to major revision since 1957. Originally, mergers merely had to be reported to the Federal Cartel Office. Legally, companies which merged had to follow the notification rule only. Now, mergers and acquisitions (M&A) must be reported to the FCO in advance, if -

- one company involved has sales of more than 2 billion DM per year, or
- two of the companies involved reach 1 billion DM sales each.

The FCO can, and must, prohibit any M&A in the event that a new company gains a dominant position in the market. A "dominant position" is assumed to exist when market share exceeds 33 percent and the merged firms have annual sales in excess of 250 million DM. There are a few more criteria which are carefully defined for the three-and five-companies cases as well.

It is important to note that the interdiction of an M&A can be overruled by the Federal Ministry of Economics, if the negative competition effects are outweighed by "economy-wide gains through the merger," or if the merger is justified by a common public interest. The Minister can impose conditions on the mergers when overruling the FCO. Present procedures with respect to M&A are thus similar to the traditional procedure of ministerial overruling of the FCO in the case of Cartels. And just as in the Cartel case, the new law on competition defines the action as a misdemeanor.

2. In the EC legislation of 1990, the intrinsic problems of defining the relevant market were avoided by relying solely on one size criteria. World sales of all firms involved reaching 5 billion ECU, in combination with EC sales of at least two firms involved of more than 250 million ECU.[6]

In other words: The EC merger regulation is no longer based on the effects on trade among member countries (as the anti-Cartel policy still is), but on clear-cut definitions of sales volumes. It is also important to note that application of the escape clause of Article 85, i.e., the "fair share" of consumers and the technical and economic progress is not explicitly excluded.

The *Daimler-Benz Merger* Controversy

The Federal Cartel Office of Germany (FCO) ruled against 15 companies and persons (as petitioners) on April 17, 1989, by prohibiting *Daimler-Benz* from buying a majority ownership position in *Messerschmitt-Bölkow-Blohm GmbH.*

In the wake of this negative ruling, *Daimler-Benz AG* applied for a special ministerial permission at the Federal Ministry of Economics, stating that the FCO's arguments

[6] It should be added that in paragraph 15 of the lengthy preamble to the Decree on the Control of Mergers and Acquisitions (*OJL 257, December 21, 1989*) the Council declares its common understanding that in the case market shares are below 25 percent within the EC (or important parts of it) merges and acquisitions can be supposed not to violate the rules of competition. The actual weight of this part of the preamble has not as yet (1992) been put to a juridical test.

were essentially misleading, and the ruling false. It is interesting to note that the "relevant market" claimed by *Daimler-Benz* was not the national German market but the international market. All in all, it was argued that the merger "was in the public interest, economically advantageous and, not least, would increase the international competitiveness of German firms."

The Federal Minister of Economics commissioned the "*Monopolkommission*," an institution similar to the Council of Economic Advisors but concerned with problems of competition policy only, to advise the government on May 2, 1989. The *Monopolkommission* rendered its special report in August 1989. It also argued strongly against the negative vote of the FCO.

1. The international competitiveness of the German economy as a whole would be improved by the merger.[7] Sectors such as the automobile production would now gain access to "system-techniques" developed by the aerospace industry. Without these techniques the future of many sectors would be endangered due to the increasing complexity of projects.

2. The monopoly profits of American aerospace companies could be prevented by competition between European *Airbus* Industries and satellite programs. The involvement of *MBB* in the *Airbus* production would be strengthened by the merger.

3. The acquisition of *MBB* by *Daimler-Benz* would secure for all companies involved the competence for system leadership.

4. The chances of participating in major-international and technologically attractive cooperations would be improved.

As a matter of fact, the *Monopolkommission*'s chairman, U. Immenga, disagreed with his fellow commissioners' opinions and resigned after delivering a dissenting vote.

The Federal Minister of Economics decided to approve the merger on September 6, 1989, by essentially following the reasoning of the *Monopolkommission*. The approval was made subject to the following conditions:

1. The *MBB* should take over the 20-percent share of the government-owned *Kreditanstalt für Wiederaufbau (KfW)* three years in advance of the already existing privatization schedule (i.e. 1996).

2. The *AEG* was to sell the divisions of its "marine technology" business, and *MBB* had to sell some parts of its "marine and special technology" divisions within two years. The owner of these divisions is now *Bremen Vulkan.*

3. The *MBB* had to sell its share of *Krauss-Maffei AG* within a year. The majority owner of *Krauss-Maffei* is now *Mannesmann.*

4. *Daimler-Benz/MBB* had to give up their stakes in a number of so-called "support companies," such as the defense consulting and research company *IABG* with some 2,000 employees.

[7]It remained unclear what was meant by the term "international competitiveness" of a whole economy. Presumably, it referred to rates of growth of the real per capita income which then ought to be above the international average, at least.

5. *Daimler-Benz/MBB* had to refrain from interlocking directorates in other companies which are in the defense business. The decision, which was hardly criticized by professional German and other economists [one exception was Glismann, Horn 1989], was presumably one of the causes why the Federal Minister of Economics resigned shortly after that event.

Information on the Ownership Structure of German Defense Contractors

Depending on their importance, we have to distinguish between two categories of arms producers; system leaders and suppliers of components. The know-how and the capacities required to integrate complex arms systems ("system capability") is a characteristic of a few large companies and, perhaps, some medium-size companies which are highly specialized in arms production, such as *Krauss-Maffei*. The majority of firms participating in the defense business are concerned merely with the supply of components and are, typically, a small or medium-size company.

Among the main defense contractors there is a host of mutual dependencies due to interlocking directorates as well as capital partnerships. For example, the main shareholder of *Daimler-Benz AG*, the *Deutsche Bank*,[8] is represented on the executive boards and supervisory boards of the following defense companies:[9] *Mannesmann AG, Thyssen AG, Siemens, Diehl GmbH & Co. KG, Rheinmetall, SEL, AEG, Klöckner-Humboldt-Deutz AG (KHD), Daimler-Benz, Feldmühle Nobel AG*, and in the recently created *DASA*. *Daimler-Benz* in turn is represented as a shareholder in its own subsidiaries *AEG, Dornier, MTU*, and *Telefunken Systemtechnik* as well as in the *Diehl Co. Siemens* is on the supervisory board of *MBB, Mannesmann AG, Thyssen AG* and *Feldmühle Nobel. KHD* is represented in the *Feldmöhle Nobel AG*. Besides, there are some private shareholders who do not exert influence as members of the executive boards, but who have multiple memberships in the supervisory boards of the companies mentioned.

Overview 1 gives an insight on the ownership structure of Germany's most important defense-contracting company, the *Daimler-Benz* company (*DB*). It is interesting to note that *DB* is connected by one-fourth with a number of banks, holding companies and insurance companies which, in turn, are partially owned by banks and holding companies.

Daimler-Benz AG owns a number of companies. Overview 2 gives information on the status in 1988; i.e., before the acquisition of *MBB*. There are three major columns visible. On the left-hand side, there are three smaller columns referring to automobile and parts-producing and distributing companies. The smaller columns in the middle contain electrical-engineering companies. On the right-hand side are the defense-oriented companies, mainly aerospace. It should be noted that similar structures of reciprocal ownership can be observed for other German companies.

The restructuring of the German defense industry in recent years was not limited to

[8]It is important to note that the *Deutsche Bank*, like other German banks, can make extensive use of the shareholders' proxies because bankers in German normally are authorized by their clientele to represent them in the annual general meeting of a company's shareholders.

[9]As discussed in great detail in Volume II, German corporations separate the Board of Director, or supervisory function, from the management or executive function. Moreover, a member of a German Board of Directors, the *Aufsichtsrat* cannot be a member of the executive group, or *Vorstand*. See Volume II for full details on these matters.

the *Daimler-Benz/MBB* case. The major acquisitions and sales of defense companies included almost all of the top defense contractors (Overview 3). *Mannesmann, Diehl* and *Röchling/Rheinmetall* have become the main producers of combat vehicles by buying up, among others, *Krauss-Maffei* and *MaK Systemtechnik*. In the field of marine technology, *Bremer Vulkan* acquired *Atlas Elektronik* and, also in the course of fulfilling the ministerial decree of 1989, *Systemtechnik Nord*, which was formed out of a number of smaller companies and, later, of some East-German firms from the *Treuhand AG*. Still in the marine field, Preussag bought up *Salzgitter AG* from the Federal and *Länder Governments*, some private shareholders, and the *Kiel Howaldtswerke AG*.[10]

Restrictions on the Export of Arms

Foreign trade in arms has always been heavily regulated in the Federal Republic of Germany (FRG). As opposed to the more liberal attitude of the U.S., the German *"Außenwirtschaftsgesetz"* (AWG; i.e., the Foreign Trade Act) of 1961 declares all foreign trade to be "principally free" (§ 1, AWG). However, a § 7 of AWG refers to the *"Außenwirtschaftsordnung;"* i.e., the Foreign Trade Directive, which specifies a number of limitations to this otherwise general statement. These limitations have been extended over time, most recently in the aftermath of the Gulf conflict. These extensions concern, first, exports of weapons and of ABC technologies;[11] and, second, exports of "dual-use high technologies." Both types of export restrictions intertwine but will be dealt with separately in the following. A third type of arms-exports restriction has become important only recently. This concerns exports of goods and technologies to developing countries.

After 1945, production of arms was entirely forbidden in Germany by the Allies. Starting with the entrance of the FRG into NATO in 1955 and its concomitant rearmament, production restrictions were slowly loosened. The major exception to the ensuing trend of liberalization today in the ABC sector, where the FRG signed a constitutional commitment stating that she would continue refraining from the production, export, storage and use of ABC technologies.[12]

Along with the liberalization of arms production, the problem of arms exports became obvious, because production was designed to attain self-sufficiency in all major fields of arms technology, complemented by international cooperation in fields where autarky would have put too much of a strain on domestic resources, e.g., fighter aircraft.

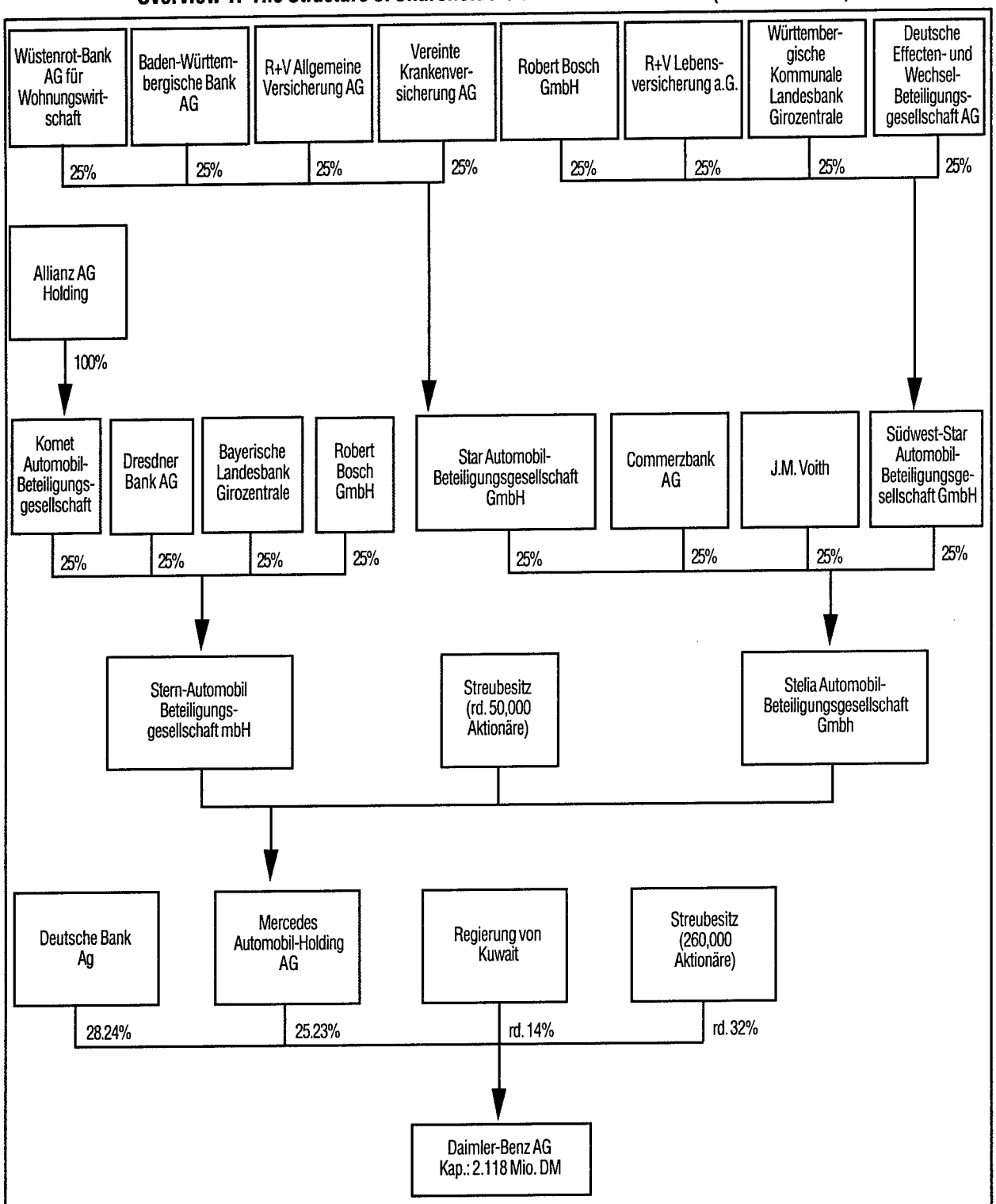
More to the point, the German constitution declares all measures illegal which may "disturb" the peaceful international "togetherness" of nations. Preparation for an offensive war is especially counter to the mandates of the German (Article 26 para 1 *Grundgesetz)*. Secondly, the production, transport, and sale of weapons is possible only with the express permission of the Federal Government (Article 26 para 2 *Grundgesetz*). As opposed to other and larger arms producing countries such as the United Kingdom, France and the U.S., the FRG, in addition, has declared her determination to prohibit arms exports, or at least to regulate them meticulously. In the

[10] The term *"Länder"* is synonymous with state-level government as it is found in the U.S. although the authority of a *Länder* most normally extends to activities and domain not normally delegated to the state in the U.S.

[11] Technologies which could be used to produce atomic, biological or chemical weapons.

[12] *Zwei-plus-Vier-Vertrag* (Two plus Four Treaty), *Vertrag ueber die abschliessende Regelung in bezug auf Deutschland vom 12 September 1990*, Article 3, paragraph 1.

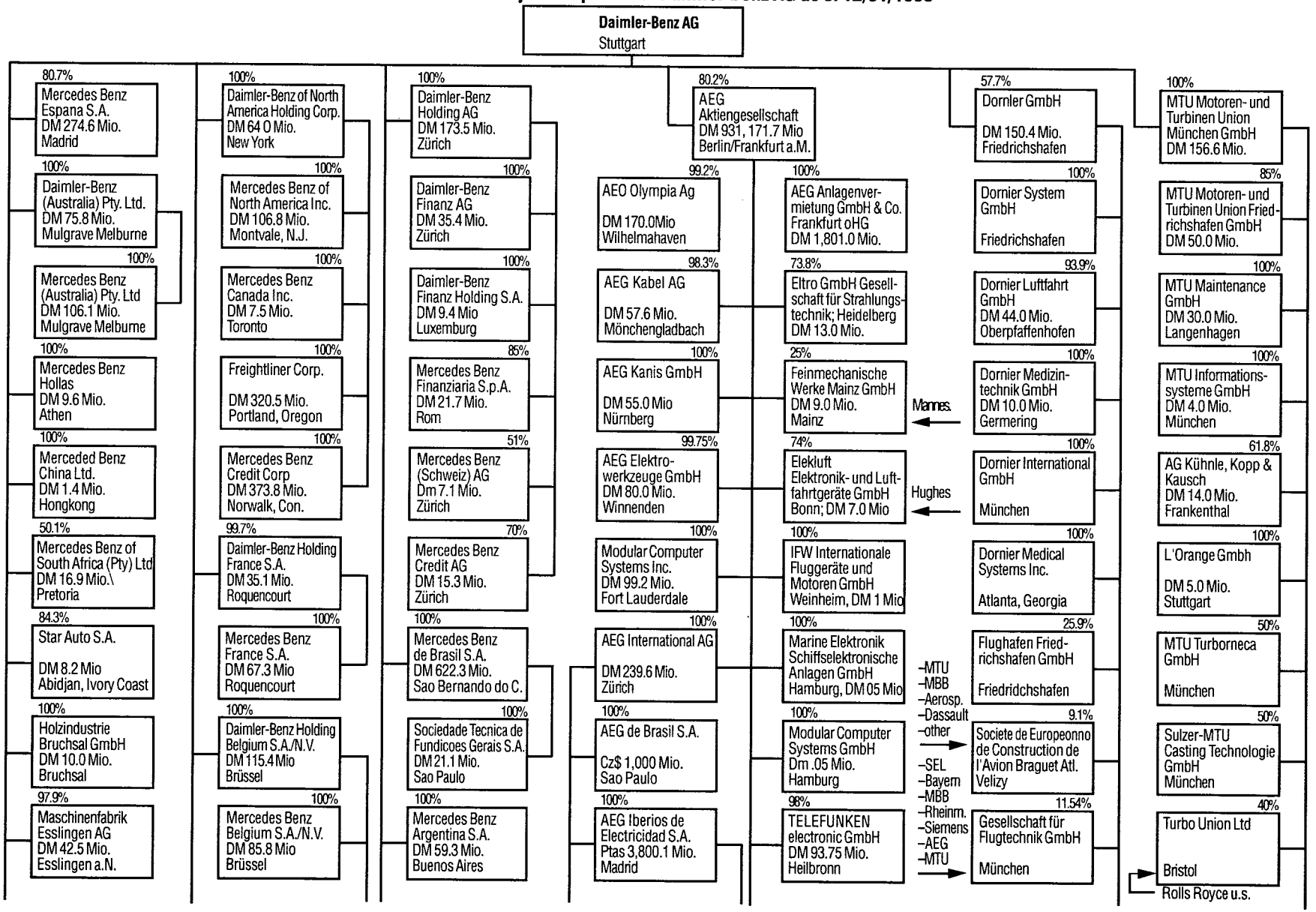
Overview 1: The Structure of Shareholders of *Daimler-Benz AG*[a] (as of 31/12/88)

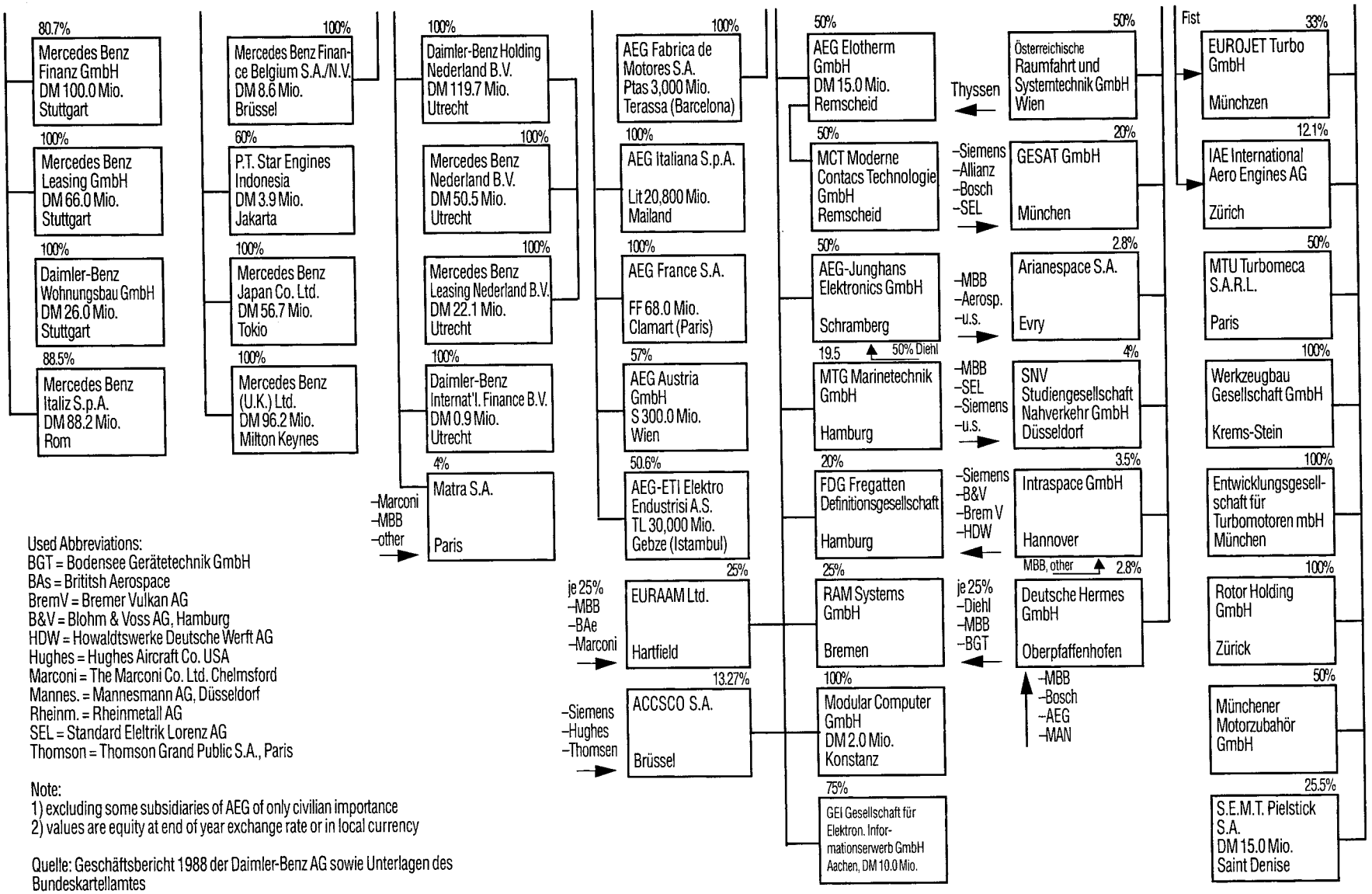


(a) Main translations: *Streubesitz*: Widely spread shareholders; *Regierung*: Administration; *Beteiligungsgesellschaft*: similar to a holding company; (*Kranken*)*Versicherung*: insurance company

Source: *Monopolkommission, Sondergutachten gemäß § 24 b Abs. 5 Seite 7 GWB*, 1988.

Overview 2: Major Companies of Daimler-Benz AG as of 12/31/1988





Used Abbreviations:
BGT = Bodensee Gerätetechnik GmbH
BAs = Brititsh Aerospace
BremV = Bremer Vulkan AG
B&V = Blohm & Voss AG, Hamburg
HDW = Howaldtswerke Deutsche Werft AG
Hughes = Hughes Aircraft Co. USA
Marconi = The Marconi Co. Ltd. Chelmsford
Mannes. = Mannesmann AG, Düsseldorf
Rheinm. = Rheinmetall AG
SEL = Standard Eleltrik Lorenz AG
Thomson = Thomson Grand Public S.A., Paris

Note:
1) excluding some subsidiaries of AEG of only civilian importance
2) values are equity at end of year exchange rate or in local currency

Quelle: Geschäftsbericht 1988 der Daimler-Benz AG sowie Unterlagen des Bundeskartellamtes

Overview 3: Major Company Sales in the German Defense Industry since 1987

Buyer	Company Sold	Seller
Mannesman	51 percent of Krauss-Maffei (1989) majority of VDO (1991) only parts, defense is important sector]	Flick Group Ms. Lieselott Schendling Rheinsbergen
Diehl	25 percent of Krauss-Maffei (1981)	Flick Group
	99 percent Bodenseewerk Gerätetechnik (1991) subsystem for air-defense	Perkin & Elmer, U.S. and private families
	95.1 percent SIVG, Neubrandeburg 51 percent FUG, Neubrandenburg (1990) maintenance of vehicles	Treuhand (probably)
Rchling/Rheinmetall	60 percent MaK Systemtechnik (1990)	Krupp AG keeps 40 percent
Bremer Vulkan	75 percent Atlas Elektronik majority of smaller marine technology firms of former GDR, now integrated in Systemtechnik Nord (STN-Group)	Krupp AG, MBB, AEG, Treuhand AG
Preussag	100 percent HDW (1989 + 90) (marine ships)	Federal gov., and state gov., Krupp AG
Daimler Benz	80 percent AEG incl. Telefunken-Systemtechnik	Public shareholders
	50 percent MBB (1989) (aerospace technology)	Govs. of Hamburg and Bayern, Dresdner Bank, Bayerische Vereinsbank
	57 percent Dornier GmbH	Dornier Family
	increase 50 percent MTU, München (50 percent were already owned by DB in 1982)	MAN AG

Source: Companies' Annual Reports. — *Commerzbank AG, Wer gehört zu wem? Vd.* 14 and 17. — Own compilations.

"Kriegswaffenkontrollgesetz" (Arms-Control Act) of 1961, which followed the allied provisos, the production, purchase and sale of arms was made conditional upon special permission of the government by enumerating the cases concerned and defining the procedures. As time went by, the procedures were changed. Most recently, in November 1990, the government raised the fines and sanctions for infringements of the law after German reunification was attained.

Arms-export regulations have quite evidently posed considerable problems for German politicians. Still, the principal political stance seems to be encompassed in the *"Politische Grundsätze für den Export von Kriegswaffen"* of 1982.[13]

> Arms exports require prior governmental approval.

Arms exports are allowed in principle only if they go to NATO countries with appropriate assurance that they will not be exported to non-NATO nations.

In the case of a cooperation with NATO countries, the FRG retains the right to interdict the arms exports of partner countries.

Exports of licenses and production facilities for arms are regulated in the same fashion as arms exports.

Arms exports into third countries are forbidden. However, the prohibition may be waived in the special case where political considerations make such exports vital to German interests.

Arms exports into third countries, however, cannot be of vital interest to Germany if these countries are under severe war-like tensions, and if the arms are not solely for defensive purposes.

Finally, and of a more recent origin (1990) is the requirement that every German arms-exporting firm appoint a member of the board of directors who will then be responsible for monitoring the export of arms. *Only* this member is allowed to deal with the appropriate governmental agencies and, if necessary, apply for permission to export military goods. Should this member be suspected of any misdemeanor on or off of the job, he must be replaced by another member. The latter then requires proper clearance by the authorities with the former excluded from any activities where export controls are relevant.

The above principle of "trustworthiness" of arms exporters applies also to a number of non-arms exports, the so-called dual goods and technologies (enumerated in the Exporting List, Section C of the *"Außenwirtschaftsverordnung"*).[14] Of concern here is the classical high-technology sector which has been under surveillance in order to prevent technology transfers into communist countries. Surveillance of these activities is under COCOM supervision and is, by and large, the same for all participating countries.[15] The goods falling under this special surveillance have been repeatedly redefined depending on the progress of technology and on the fluctuations of international tensions and detentes. In light of the Persian Gulf War, controls of all kinds of exports have been reinforced with respect to trade with less-developed

[13] *Beschluss der Bundersreierung,* Bulletin of 5 *Mai* 1992 *Bundesanzeiger Jg.* 43, 25 Jan. 91. Nr. 17a, pp 161 sq.

[14] *Grundsaetze der Bundesregierung zur Pruefung der Zuverlaessigkeit von Exporteuren von Kriegswaffen und ruestungsrelevanten Guetern.* p. 165 sq.

[15] COCOM, the Coordinating Committee for East-West Trade has been in existence since 1949. COCOM defines the minimum requirements for export controls on strategically important goods and technologies.

countries. To prevent "evil" governments from gaining access to arms or dual goods and technologies, the German government decided to have almost all exports scrutinized. In case exports are designed to either construct, run or be part of facilities with military uses, they are under strict licensing if the destination is one of 53 countries enumerated in "country list." Every exporter, therefore, has to be able to give testimony about the final destination of their product, and on its end use.

Exporting from Germany has become a dangerous business. Two new bureaucracies were established after 1990 to exert control (including phone tapping) on companies and to handle the red tape and the sanctions; the "*Bundesausfuhramt*" (Federal Export Office), and the "*Zollkriminalamt*" (Customs Criminal Office). It is still a controversial issue whether these offices are compatible with EC law, and whether, within the framework of the Single European Market, these regulations and institutions are appropriately established.

Capital Markets

The in-house development of new technologies as well as the use of imported technologies absorbs resources, and the outcome of any such activity depends on the business and financial risks and uncertainties involved. In an advanced economy such as Germany which competes in the higher ranks of the international technologies race, the supply of venture capital for the development and production of new technologies is, therefore, a critical factor in economic growth. It has been argued that the relatively slow economic growth of Germany as compared to the U.S. and Japan is, to a considerable extent, the result of an insufficiently functioning venture capital system. In comparison to the U.S., for instance, in Germany, the emergence of new technology-oriented firms has played only a minor role in its industrial development [Weichert 1987].

There are salient and rather stable features of the capital markets in Germany. However, they differ from the patterns observed in the U.S. Taking data for the year 1991, for example, capital formation in the private enterprise sector amounted to 497 billion DM, i.e., 19.1 percent of gross domestic product.[16] Of this sum:

1. 292 billion DM (or 59 percent) was provided by internally generated cash flows;

2. 9 billion DM was raised by the issuance of common stocks. Thus, funding from equity sources provides a minor portion only of corporate capital needs;

3. Corporate bonds sold amounted to only 8.5 billion DM. This also reflects a peculiarity of German bond markets. Less than one percent of circulating bonds are corporate bonds. Industrial corporations rarely use this financial instrument. The bond markets are dominated by government bonds and by the bonds of financial intermediaries;

4. 136 billion DM (or 27 percent) was financed by bank loans. This means that bank loans are by far the most important source of external funds; and

5. Other loans (including loans from insurance companies and other financial intermediaries, loans from the

[16]The data are taken from the *Deutsche Bundesbank, Vermogensbildung und ihre Finanzierung in der Bundesrepublik Deutschland im Jahre 1991. Monatsberichte der Deutschen Bundesbank, Mai* 1992, p. 15 sqq.

government, or newly built-up pension reserves within firms) amounted to 31 billion DM.

The patterns in financing capital formation reflect, for one thing, the predominance in Germany of limited liability corporations (*Gesellschaft mit beschränkter Haftung* or *GmbH*). The market value of public corporations (*Aktiengesellschaft, AG*) whose shares are traded on stock exchanges is only about 25 percent of *GDP.* This reflects the fact that tax regulations, in particular the *Gewerbesteuer* ("business tax") discriminate between equity capital and outside loan financing, and raise the "costs" of equity-capital financing in relative terms. In addition, until recently, the costs of raising equity in the securities markets were substantial. Major changes in this respect during the last years include the abolishment of the special sales tax for stocks and securities trading at the stock exchanges, and the special tax on the issuance of new stocks. Moreover, in recent years the German system of stock exchanges has been reorganized substantially in order to increase efficiency and to allow for the trading of new financial instruments. It remains to be seen, however, what effects these changes will have on the capital formation process in Germany.

Notwithstanding this, it appears that capital-market distortions primarily effect the access to risk or venture-capital market by small, medium-sized and new firms. Large firms with international activities do not face any special barriers to the financing new business or products either in domestic or foreign markets. In comparison to the U.S., Germany differs in particular with respect to the foundation of new firms and with respect to financing the development of new technologies in smaller firms [Birch 1984]. The following factors appear to be the most critical.

First, the opportunity costs for the potential founder of a firm are lower in the U.S. than in Germany. New technologies are quite frequently developed by employees in universities, in research laboratories and in large firms. It can be expected that the incentives for employees to organize their own firm are higher, if the expected reward for their ideas in the old firm is lower, or if the cost for a change into self employment is lower.

In Germany, the employee-invention law provides an *obligatory* reward for employees who develop inventions. This regulation tends to bind creative employees to their firm since an employee who leaves the firm gives up his rights to this invention.

In addition, the pension system in Germany discourages employee mobility. Researchers at universities or at associated research institutions are, more often that not, tenured civil servants. They have pension claims (provided that they stay in the civil service) which are much higher than are attainable in private sector.

Secondly, the U.S. and Germany differ in regard to tax regulations. In Germany, new firms have to pay value-added tax even if they are not profitable.

Third, with respect to the formation of technology-oriented firms or with respect to smaller firms in general, in the U.S. venture-capital firms are available as a source of entrepreneurial capital. Conversely, in Germany new technological ideas seem to be considered with reserve by private investors, The U.S. is, by far the largest market for risk capital for new and smaller firms with more than 700 venture-capital firms acting as intermediaries between private investors and firms. A considerable part of the funds raised by American ven-

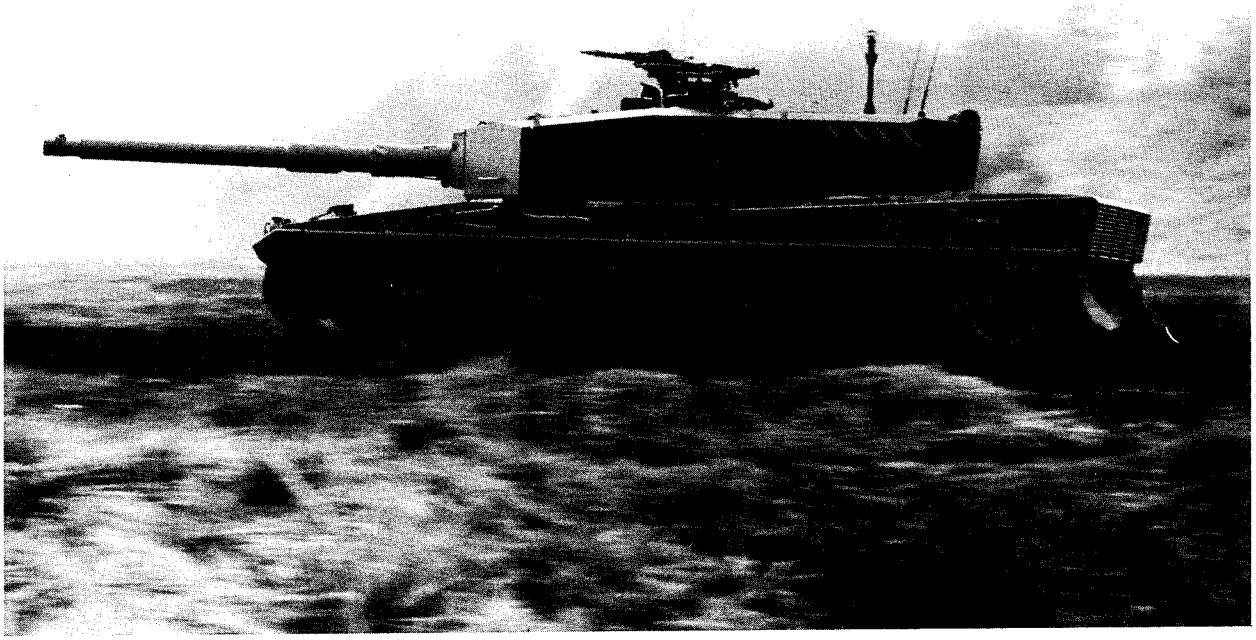
ture-capital firms even comes from abroad. There are few such firms in Germany.

With regard to the assessment of the efficiency of capital markets, some arguments allude to the (traditional rules of) conduct of market factors which are empirically hard to test. One such argument is that job risk is relatively high in the U.S. In this context, spectacular cases of mass redundancies of research personnel are often quoted (NASA after completion of the Apollo program; Boeing Aircraft Company in the early 1970s). One also must take into account the substantial fluctuation in the number of scientific personnel in connection with the beginning and the ending of research projects and, more generally, the predominance of the hire-and-fire system. This is to say that there is less job security in research and development in the U.S. than in Germany. Thus the motivation for founding a new technologically-oriented firm is greater in the U.S. than in Germany.

With respect to the conversion problem, it can be argued that the challenges of restructuring should pose less of a problem in the U.S. if only because of the availability of venture capital. The main reason is the greater flexibility of the system which prevails in the U.S. Supply conditions for risk capital and the flexibility of research manpower make it more probable that scientists will create their own firms in the event there are redundancies in the defense industrial sector.

Concluding Remarks

When compared to the U.S., the German system of industrial organization exhibits some features which tend to increase and some which tend to decrease its international competitiveness. The German system also affects the scope for adjustment to changes in the governmentally created industrial demands. For example, the mere fact that U.S. venture-capital markets are more efficient than the German ones points to but one aspect of the adjustment potential. It may well be that other aspects outside,such as the educational system, or inside the capital market,such as the famous alleged "relationship banking" in Germany as opposed to the alleged "arm's-length" strategies in the U.S., compensate for this and make the whole system more flexible. In other words, whereas some of the marginal productivities may now and then indicate otherwise, the overall comparative productivity of the German system may be fairly high.



ABOVE: Leopard Tank

BELOW: M-1A1 Main Battle Tank

6

HUMAN RESOURCES PRACTICES

Introduction

In one way or another, labor costs reflect labor productivity. In Germany, a major part of total labor costs is absorbed by the costs of the "social system". These latter costs include taxes, social security payments, paid sick leave, paid holidays and maternity leave, paid vacation, and other benefits. For example,

1. By legislation, every worker or employee has the right to have at least a paid 3-week vacation;

2. Maternity leave is paid for 14 weeks. In addition, for another 12 months lump-sum payments per month are available from the tax payer for every young mother. In addition, it is possible (for the mother or the father) to get a 3-year "education" leave without payment for the last 2-years, but with the right to return to his or her former job.

De facto, agreements between trade unions and employers' organizations fix conditions which are often superior for the worker than the minimum conditions laid down by the law. For example, the contractual benefits include annual paid vacation of (today) 30.4 days,- excluding Saturdays and Sundays, for the average employee.

All in all, in 1991 total labor costs per average worker as shown in national accounts statistics amounted to 54,108 DM with take-home pay at 29,705 DM.[1] These figures are based on a recalculation of national accounts data. It must be kept in mind that conditions of the labor market are not fully reflected in the national accounts. For example, the rate of unemployment, which has been relatively high since the mid-1970s, is a function of total labor costs, not take-home pay. Thus government's taxation, as well as security payments and legislation, affect the unemployment rate the same way wage agreements do. With less paid holidays net take-home payments could be higher at the same rate of unemployment, or, the rate of unemployment could be lower at the same take-home pay.

The barriers, such as those noted above, to structural change in the labor market can have particularly serious effects, if those firms which are active in international markets seek to evade domestic regulations by moving their operations abroad. In Germany, such barriers to structural change result from compulsory government regulations as well as from private regulations by interest groups exerting market power.

1. Minimum wage regulations exist in the United States (U.S.) as well as in

[1]The absolute numbers are in nominal terms. Take-home pay rose on average by 3.1 percent per year between 1980 and 1991. Since the average rate of inflation was 2.7 percent per annum for the same period, real income of employees almost stagnated. From the above, it follows that the dues accruing to governmental services, including social security, rose on average by 4.5 percent per year.

in Germany. In the U.S. minimum wages are set by government and are uniformly valid for all employees. Generally, German industry-specific wage settlements are between unions and employers' associations. These frequently are made binding for non-members of these contracting parties by a government decree (*"Allgemeinverbindlicherklärung"*). Firms can pay higher wages than the fixed regular and generally binding rates. It appears that the German system of wage fixing is a major rigidity in the market and has contributed much to the employment problems in recent decades.

2. Other legal regulations which constrain the freedom of contracts in the labor market also exist in Germany but apparently not to the same extent as in the U.S. Examples are: protection against wrongful dismissal; legal protection of expectant and nursing mothers; protection against youth employment; regulations governing industrial relations and the codetermination rights of labor, and the regulation of continued payment of wages in case of illness or leave.

3. In Germany, firms restructuring or entering bankruptcy have special obligations. In particular, firms have to provide for a social compensation plan in the case of redundancies in the labor force. This raises the costs of intrafirm restructuring and impedes the raising of external funds, because business loans are given lower priority in bankruptcy and restructuring actions than are social compensation requirements.

In addition, there are other inflexibilities and rigidities in the German labor market. These inefficiencies are reflected in the enormous increase in unemployment and in the virtual stagnation of real take-home pay per employee in Germany since 1980.

The Educational and Vocational Training System

It is almost a truism that the technological capability of a country is primarily dependent on the quality of its educational and vocational training system, and most importantly, on the proportion of qualified natural scientists and of technicians in the population. For example, the comparatively high rates of economic growth in Germany before World War I and the relatively slow economic growth in the United Kingdom at the same time has been ascribed to the fact that the educational system in Germany was directed strongly toward the natural sciences and technical education.

Thus, the hypothesis is that countries who invest in education and, most of all, in technical education or in the education of large numbers of natural scientists, are the most capable of generating new and marketable technologies.

In order to arrive at some empirical assessment for Germany and the U.S., it will be assumed that (i) the level of qualification of labor can be measured by its formal education; (ii) the technological capability of a country is determined by the number of people who have received a diploma in the natural or technical sciences at a university; and (iii) every diploma within a certain sector of education is of the same value in the Federal Republic of Germany (FRG) and in the U.S. (i.e., each diploma recipient has the same marginal productivity). The share of qualified labor with a diploma within the total population should then correlate signifi-

Table 4. Indicators of the Efficiency of Educational Systems in (West-) Germany and the United States

Fields	Patents Granted[a]		Citations[b]		Educational Status[c]
	1973	1980	1973	1980	
Mathematics, Physics, Chemistry					
FRG	34[d]	34[d]	1189	1121	681[e]
U.S.	27[d]	24[d]	1230	1222	2676[e,f]
Engineering					
FRG	123[g]	112[g]	158	196	5092[e]
U.S.	155[g]	106[g]	307	374	14965[f]
Medicine					
FRG	–	–	1012	1507	3162[e]
U.S.	–	–	2362	2710	3781[e,f]
Natural Sciences Total					
FRG	178[h]	170[h]	2359	3124	8935[e]
U.S.	223[h]	162[h]	3899	4306	21422[e,f]
All Fields					
FRG	178	170	–	–	32171
U.S.	223	162	–	–	75243[f]

(a) Number of patents granted in the United States per million inhabitants, corrected for the "home advantage". The home advantage is measured by calculating the patents granted to Germans in the United States with the help of the relation of patents granted to Germans in the Federal Republic and in the United States. The factors are for 1973: 1.97; 1980: 1.83. – (b) Citations of the respective scientific literature in publications of all other countries, per million inhabitants. – (c) Employed academics per million inhabitants.– (d) Chemical and allied products. –(e) Without teachers. (f) –1982. –(g) Metal ware (excluding machines), machines, transport equipment, instruments.(h) All patents granted

Source: Börnsen, Glismann, Horn [1985].

cantly and positively with the number of patents granted per inhabitant, that is to say, the efficiency of its "R&D system."

As shown in Table 4, with respect to the natural sciences, R&D efficiency was higher in Germany in 1980 as compared to the U.S. Germans received 170 patents per million inhabitants in 1980, whereas U.S. citizens received only 162 patents per million people in the same year. To be sure, this relationship for natural scientists as a whole was reversed in 1973 when the U.S. had a remarkable lead. However, if R&D efficiency is defined by the ratio of patents granted (indicating scientific output) and the number of natural scientists (indicating costs), the Federal Republic also showed a significant advantage in R&D efficiency also in 1973. As compared to the U.S., the number of patents granted to German natural scientists and engineers was about 1.9 times higher in 1973 and 2.5 times higher in 1980.

Table 4 also provides data that shows that in the FRG, R&D efficiency is much higher in the fields of mathematics, physics and

chemistry than in the natural sciences. This may indicate that too few R&D resources go into these fields. Theoretically, R&D inputs would be optimal, if all fields exhibited the same marginal productivity.

There is a danger of misinterpretation of patent statistics. The empirical basis of the above is small, and the value of each patent granted is unknown. On the other hand, the "international index of citations" points in the same direction as the patents granted. With respect to the citations, the U.S. improved its relative position in all fields covered by Table 4 which may well be the result of language barriers. Nevertheless, according to this indicator, R&D efficiency is higher in the FRG than in the U.S.

However, the qualification of a person cannot be measured by the formal status of education alone. There are other non-formal factors which cannot be quantified as easily. It could also be that the role of natural scientists and technicians is not as important for the technological capability of a country as some of the data imply. What seems to be most plausible is that the assumptions underlying Table 4, namely that natural scientists have the same marginal product in all countries, is not realistic. This argument can be based on the law of diminishing returns, which means only a small part of a population is intellectually able to enter new technological fields. There is an increasing number of natural scientists in the population, and the share of those who are less capable to be creative in technological terms must rise. This would explain the above results of R&D efficiencies in both countries. The proportion of natural scientists as a percentage of the total population of the U.S. is more than twice as high as in Germany.

On the other hand, there are factors which may lead to the conclusion that the U.S. has a superior technological position over Germany, in case both countries had the same share of natural scientists in the population:

1. The U.S. has private universities. The students at these universities must pay for their education.

2. The average age of full-fledged academics in the U.S. coming from universities is far lower than it is in Germany.

3. Professors in the U.S. do not automatically have tenure. Moreover, there is no unified system of payment of professors.

4. The quality of universities and their academics in the U.S. is of a great variance. Transparency about this point is relatively high in the U.S.

These factors are economically important. They indicate that the supply of education in the U.S. is more competitive, and those who demand education have stronger incentives to be successful. If the assumption is correct that the creative potential declines with a person's age (and that the importance of on-the-job experience increases), the American system would create, in absolute terms, more creativity. In addition, the productive factor "on-the-job experience" is used more frequently in the U.S., not least because the age of retirement is reached later in the U.S. than in the FRG.

The sheer relative size of the educational system of the U.S. leads to the assumption that the export potential in technologies is greater in the U.S. than in the FRG. This higher potential of transfers is corroborated also by the bibliometric data in Table 4.

Defense Companies as Developers of Technologies

The salient misunderstanding of Heraclitus' phrase, "War is the father of all things," suggests that war has been regarded a major source of technological advance. In the absence of hot war, it can be argued that a permanent external threat may serve as a substitute propellant. By tradition, armament is striving for first-best techniques in order to win a potential war. Since man has to do in war with all-or-nothing decisions, technological backwardness may indeed turn out to be fatal. This striving for technological excellence, an ever-popular cause for arguments between finance and defense departments, does not leave the civilian sector untouched. In fact, it is commonly viewed that the development of military technologies, or goods at large, has positive side-effects (spin-offs) for the whole economy.

Although the debate about spin-offs of arms production has not produced definite positive (or negative) results [Chakrabarti, Glismann, Horn 1992], the major defense contractors and their subcontractors and suppliers, in many cases, produce at the technological frontier, regardless of whether they also aim at spin-offs or "only" at technologically sophisticated weapons.

It has been shown that among the individual German arms-producing firms, *MBB* is the outstanding German firm with respect to patent applications. The *MBB* applied for more than 400 patents between 1985 and 1989. Second to *MBB* was *Siemens* (about 165 applications). Third was *Diehl* (138), and rank four was *Rheinmetall* with 106 applications [Berger et al., *op.cit.*, p. 223].

An international comparison under the same criteria (i.e., two-country application; 1985-1988) was also presented in the *Ifo* study quoted above. It shows a predominance of German companies regarding military inventions (Table 5).

Table 5. Patent Applications by Companies and Product Field, Ranks 1985–1988

Company	International Ranking[a] with respect to			
	Military Electronics	Aerospace	Weapons and Ammunition	Military Explosive
MBB	5	1	3	–
Diehl	–	14	2	–
Siemens	3	12	–	–
Rheinmetall	–	–	1	–
Bosch	–	13	–	–
Bayer Chemie	–	–	–	3
Dynamit Nobel	–	–	–	4
Fraunhofer Gesellschaft	–	–	–	9

(a) Among the world's 15 most important patent applicants with applications in at least two countries.

Source: Compiled from Berger et al, *op. cit.*, p. 223.

Considering the relatively low level of German arms production and export, the seemingly high technological efficiency comes as a surprise. Most probably, there is a measurement bias implied. For example, the criterion of two-country counts may understate the importance of U.S. companies, because these can be expected to be applying for patents only on the national market. In addition, secrecy requirements may prohibit many companies in other countries from applying for patents.

Table 4 may serve to rectify the patent count. It shows about patenting performance of, among others, German firms on the U.S. market. Average performance of all industrial German firms between 1963 and 1983 was such that per 100 patents granted to U.S. citizens and firms, 11 were given to applicants of German origin. This made Germans the most successful of all foreigners. However, the relative dynamics show that Japan was the most promising country with respect to technological advance. Indeed, in 1990, Japan was second to the U.S. with respect to patents granted in the U.S. market. Per 100 patents to U.S. firms and citizens, 41 were issued to Japanese firms and citizens, and 16 to Germans.

When analyzing those SIC fields which come close to the military fields as shown in Table 5, one finds that Germany was leading among foreign countries in only one line of production in 1990, namely in ordnance. From 1985 to 1988, German inventors were also leading the group of foreigners in the field of "guided missiles." Comparison with the U.S. shows 33 German patents in SIC group 348 per 100 U.S. patents, and 14 in group 376 between 1985 and 1988. In addition, one can observe a relatively strong German position in 1990 in the field of "aircraft and parts" (SIC 372), with Japan outperforming Germany and even challenging the leading role of the U.S. on her own market. Among the five SIC groups considered, Germany has had an increasingly weaker position in "electronic components" (SIC 366 plus 367).

All in all, though the general patent statistics do not suffice to refute the surprisingly positive account of German military technology shown in Table 5, it tends to reduce its value somewhat. In the U.S. market, the U.S. is clearly leading in absolute terms across all militarily relevant SIC groups, though not as clearly as on average for all industries. Second to the U.S. in these military groups is Japan. Thus, a two-country bias in the Ifo-patent statistics clearly exists as there is a one-country bias concerning the U.S. in the U.S. patent statistics.

APPENDIX A
The Division of Labor Among NATO Countries

Based on the data on shown in Table 7 on the structure of world trade in major conventional weapons, an assumption can be made assumed that this trade is heavily influenced by political considerations and interventions. In other words, these structures do not reflect comparative-cost advantages as do trade structures of civilian goods. The degree of this divergence can be assessed by comparing trade structures in comparable civilian goods (not presented here) with the trade structures of Table 7.1

The evidence, with respect to some of the larger NATO member states, is compiled in Table 7. In the event that arms trade is just like trade in civilian goods, the coefficients in Table 7 would all be zero. In the case of a preferential arms trade, the coefficients would be positive. In the case of discrimination in arms trade, the coefficients would be negative. The Table shows there seems to be no preferential treatment of arms trade among the NATO countries considered. In fact, the negative coefficients indicate almost maximum mutual discrimination. The division of labor in military products is much less developed than even sheer neutrality *cum economic* interest would suggest.

Table 7. Intra-Alliance Revealed Political Preferences[a]: The Case of Selected NATO Member States in 1985

	Importing Country			
Exporting Country	**U.S**	**France[b]**	**U.K.**	**FRG**
U.S	–	-1	-0.6	-0.6
France[b]	-0.9	–	-1	-0.9
U.K.	-0.6	-1	–	-0.6
FRG	-1	-1	-0.7	–

(a) Ratio of arms-export shares between two of the countries considered and the respective share of SITC-7 products (between the same countries) minus one.
(b) Contracting party to a NATO but not part of the integrated military command structure.

Source: Glismann, Horn 1990.

[1]For an extensive discussion and the detailed methods of calculation see Glismann, Horn (1990), pp 2 & 10.

APPENDIX B
Germany's Role In The International Arms Trade

The regional structure of world arms trade is not readily available. As a matter of fact there seems to exist little more than the matrix developed by Glismann and Horn [1990] covering the year 1985. The three standard sources for arms statistics, namely Stockholm International Peace Research Institute (SIPRI), the United States Arms Control and Disarmament Agency (ACDA) or the International Institute of Strategic Studies (IISS) provide at best an export/import matrix for few arms exporting countries only, e.g., SIPRI 1992.

In Table 8, export (import) sales are summed up for the 5-year period of 1987 to 1991 in order to circumvent any random outcomes found in a specific single year. The main exporters were the United States (U.S.), and the USSR in that period with a share of 34 percent and 35 percent, respectively, in world exports. The main importers were the developing countries with more than 61 percent of world imports. With respect to exports, Germany is of only marginal importance on the world market for major conventional weapons.

The structure of exports of the individual countries exhibits strong similarities between the U.S. and Germany, whereas France, the United Kingdom and the USSR had much different regional export structures: 40 percent (U.S.) and 30 percent (Germany) of arms export were delivered to the less-developed countries; the respective share of the other countries were more than twice as large. Divergences between the U.S. and Germany occur with respect to European outlets, with the U.S. supplying 28 percent of her exports to EC countries, and Germany supplying 51 percent of her exports to non-EC European countries (and only 17 percent to EC countries).

The import structures are more peculiar than the export structures, with the U.S. being of no importance at all as an importer and Germany's import share being two and a half times as high as the U.S. share. Even France and the U.K. imported more than the U.S. in absolute terms.

It is interesting to note that the effects of a scale down in arms sales quite obviously has already taken place in the period covered by Table 8. The world market for heavy conventional weapons shrank by more than 50 percent in the four years after 1987. Of the individual regions which can be accounted for, the U.S. had to cope with the least reduction in export demand (-19.8 percent). This relatively good performance of the U.S. was most probably due to the expanding demand of EC countries; the latter were the only major regions to raise arms imports. The most important effect, of course, was the drastic decline of LDC's demand for weapons.

In a recent publication a more disaggregated overview of world arms trade was given for 1985 (Table 9a). This world matrix of trade in major-conventional weapons was com-

piled by giving each transaction in a certain weapon the same weight ("transaction" referring to contracts or deliveries made in 1985; see the notes to Table 9a) - independent from the number of weapons and from the value of the transaction. The underlying hypothesis was that, in the case of the number of notifications being large enough, the errors tend to be small.

Even when allowing for the inherent limitations of the fact-finding process, the world trade matrix reveals that arms trade within each of the two big military alliances is of a lesser magnitude than one might expect. The share of intra-alliance trade is 18.4 percent in the case of NATO, and 16.5 percent in the case of the Warsaw Pact. In addition:

1. The main industrial countries and the USSR imported very few major conventional weapons, not even from the member countries of the respective alliance;

2. NATO is different from Warsaw Pact countries in that its supply is not left almost exclusively to the leading country.

3. The main export markets of all countries considered are the less-developed countries, i.e., almost 90 percent of France's arms exports are to LDCs.[1]

4. Less-developed countries provide 10.8 percent of world arms supply and account for three quarters of world arms demand. Their exports go almost exclusively into other Third World countries (intra-LDC trade).

Table 8b provides a compilation of trade in licenses. Such trade can be considered a substitute for trade in products, though not a perfect one. License production normally takes more time than direct importing, i.e., may come too late, and it takes more indigenous know-how. The advantage of license production is, on the other hand, that the recipient country becomes less dependent on foreign arms supply in the long run. It can be expected that in periods of actual international conflicts of a country, the short-run demand for military hardware is high relative to the demand for licenses. Longer lasting periods of peace may give trade in military licenses a competitive edge. Though one should be cautious to avoid an interpretative overkill, Tables 8a and 8b would also suggest that:

1. The two alliances as well as their member countries (except the U.S.) internally prefer trade with arms licenses to trade with arms;

2. The less-developed countries prefer weapons imports to the knowledge of how to produce them. This is reflected in the relationships between the alliances and less-developed countries: both alliances cooperate less with LDCs in the licensing of indigenous arms production than could be expected in view of the volume of arms trade; and

3. The FRG is an exception to this pattern.

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[1]For an in-depth analysis of arms trade with the Third World, see Clawson (1986) and Coker (1985).

Table 8. A World Matrix of International Trade in Major Conventional Weapons 1987-1991 (a)

Exporting Country / Importing Country	World Total	U.S.	Industrial Countries	Europe	EC	Germany (c)	France	UK	USSR	LDCs
World Total	174 538(b)	38.7	0.8	29.6	12.3	2.0	1.0	0.9	1.7	61.3
of which										
Industrial Countries	92.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a
of which										
United States of America	34.4	20.8	-	12.6	9.8	1.9	0.9	0.7	0	13.3
Europe	57.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
of which										
EC	18.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
of which										
Germany (c)	3.5	2.5	0.1	2.4	0.6	-	0	0.0	0	1.0
France	6.4	1.2	0.0	1.1	1.0	0.0	-	0.1	0	5.2
UK	5.2	0.9	0.2	0.4	0.3	0.0	0.0	-	0	4.4
USSR	35.1	9.1	0	9.1	0	0	0	0	-	26.0
Less Developed Countries	7.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

(a) At 1990 prices. With the exception of world exports and world imports (see fn b) in percent of "World Total."
(b) Million U.S. Dollars. - (c) West Germany only. - (d) Including Israel and South Africa.

Source: SIPRI Yearbook 1992. - Authors' compilations and calculations.

Table 8a. The Regional Structure of Arms Trade (Major Conventional Weapons) (a), Status 1985

Importing Country / Exporting Country	NATO					Warsaw Pact	Less-Developed Countries	Other Industrial Countries	Total	Structure of World Supply
	Total	U.S.	France (b)	U.K.	FRG	Total	Total	(c)		
NATO Total	18.4	1.3	0	1.8	1.2	0.2	73.9	7.5	100	67.7
U.S.	24.3	-	0	2.6	1.9	0	65.5	10.1	100	30.2
France (b)	8.2	0.8	-	0	1.6	0.8	88.5	2.4	100	14.6
U.K.	14.9	6.0		-	4.5	0	73.1	12.0	100	8.0
FRG	28.1	0	0	3.1	-	0	59.4	12.5	100	3.6
Warsaw Pact Total	0	0	0	0	0	16.5	80.4	3.2	100	17.9
Less Developed Countries Total	4.2	2.1	0	0	0	0	95.8	0	100	10.8
Other Industrial Countries (c)	9.4	0	0	0	0	0	71.9	18.8	100	3.6
Structure of World Demand	13.2	1.1	0	1.2	0.8	3.2	77.3	6.4	100	100

(a)On the basis of the number of transactions with major conventional weapons (actual deliveries plus orders in 1985). (b) France is a contracting party to NATO, but no part of the integrated military command structure. (c) Nonaligned countries (Austria, Finland, Ireland, Sweden, South Africa, Switzerland, Yugoslavia) plus Australia, Japan, New Zealand.

Source: Stockholm International Peace Research Institute (SIPRI), World Armament and Disarmament. - *SIPRI Yearbook 1986*, Oxford, New York 1986. - Authors' compilations and calculations.

Table 8b. The Regional Structure of Trade in Licenses for Arms Production (Major Conventional Weapons) (a), Status 1985

Importing Country / Exporting Country	NATO					Warsaw Pact	Less-Developed Countries	Other Industrial Countries	Total	Structure of World Supply
	Total	U.S.	France (b)	U.K.	FRG	Total	Total	(c)		
NATO Total	31.5	0.9	0.9	2.7	0.9	2.7	44.1	21.6	100	83.5
U.S.	43.9	-	1.8	5.3	1.8	21.1	35.1	100.0	100	42.9
France (b)	23.8	0	-		4.8	9.5	57.1	9.6	100	15.8
U.K.	8.3	8.3		-	0	8.3	75.0	6.0	100	9.0
FRG	17.6	0	0	0	-	0	76.5	5.9	100	12.8
Warsaw Pact Total	0	0	0	0	0	50.0	41.7	8.3	100	8.9
Less Developed Countries Total	20.0	0	20.0	0	0	0	80.0	0	100	3.8
Other Industrial Countries (c)	0	0	0	0	0	0	80.0	20.0	0	3.8
Structure of World Demand	27.1	0.8	0.8	2.3	1.5	6.8	46.6	19.5	100	100

(a) Number of license agreements for actual or pending production. (b) France is a contracting party to NATO but no part of the integrated military command structure. (c) Nonaligned countries (Austria, Finland, Ireland, Sweden, South Africa, Switzerland, Yugoslavia) plus Australia, Japan, New Zealand.

Source: Stockholm International Peace Research Institute (SIPRI), World Armament and Disarmament. - *SIPRI Yearbook 1986*, Oxford, New York 1986. - Authors' compilations and calculations.

APPENDIX C
A History of the Development Phases of the Leopard-1 And Leopard-2

Introduction

This section will sketch the historical development of the Leopard-1 and Leopard-2 tanks inasmuch as many of the steps in this development process have served to influence the current situation, as well as the future development of the world tank industry. In this regard, "history" refers to the experiences with international cooperation, to the procurement policies adapted by various nations, and also to the division of labor among the firms involved in the production of tanks. Much of this history is also central to the problem and prospects for conversion in the industry.

With more than 5,000 main battle tanks (MBTs), Germany has the second largest tank force in NATO. The *Bundeswehr* had started in 1956/57 with M-48 tanks delivered by the United States (U.S.). At the same time, the Federal Ministry of Defense (MoD), together with the Ministry of Economics, had launched a study investigating the industrial potential of tank production, because there was wide agreement that the M-48 tanks would not fulfill German defense requirements in the longer run. (By the way, the conversion of those M-48 tanks into minesweepers is the only Army project in Germany today which is untouched by drastic reductions in the long-term planning of the *Bundeswehr.*

The study of the German tank-building potential was the basis for the tank industry which has produced two MBTs since: the Leopard-1 (total production 4,300; delivery of 2,400 to the *Bundeswehr* between 1965 and 1976) and the Leopard-2 (total production approximately 3,000 until 1992; delivery of 2,024 to the *Bundeswehr* between 1979 and 1992). These two tanks will also most probably remain the only MBTs of German production since the MoD definitely canceled the successor Leopard-3 program (which had still been part of the official planning at a volume of 9.35 Billion DM).

Table 10: Number of Main Battle Tanks in Selected NATO Countries as of 1991 [a]

German	U.K	France	Italy	U.S. Army
655 M-48 2370 Leopard 1 2024 Leopard 2	450 Challenger 830 Chieftain 620 Centurion	1340 AMX-30	313 M-47 300 M-60 920 Leopard 1	1013 M-48 7987 M-60 6440 M-1
5051 Total	1900 Total	1340 Total	1533 Total	15440 Total
(a) Including stores.				

Source: The International Institute for Strategic Studies, The Military Balance 1990-1991.

The Main Phases of Tank Development in Germany.[1]

1956-63: The study by the German authorities on tank-manufacturing potentials in the German industry laid the economic and technological ground for the creation of a tank industry. A government agreement with France in 1957 then provided the (in Germany) necessary political basis, and initialized a French-German cooperation for developing a standardized European tank. Italy joined as a "neutral;" i.e., non-producing, country in 1958. The intended procedure was to develop a prototype tank in France and Germany at the same time, and then select the superior one, or the sum of the superior components for series production. Conflicts arose because military requirements of each of the two countries were bindingly formulated only after strengths and weaknesses of both tanks had in part become evident; these criteria were thus, and understandably so, biased toward the respective domestic product. In fact, the French had the superior turret (including gun), the Germans the superior chassis. A compromise through the combination of both these components was impossible due to incompatibilities in size. The sudden purchase of 1,500 tank guns (including ammunition) in the U.K. by the German Minister of Defense, which took place without informing the French partner, abruptly ended the cooperation in late 1963. The German side finalized their tank, named Leopard-1, of which the first tanks were supplied to the German Army in 1965.

1963-1970: Some months before the end of the French-German cooperation, the German and U.S. governments already agreed upon the development of a standardized MBT 70 in August 1963. In contrast to the French program, which was based on the idea of a two-country competition, in the American-German cooperation a common development was sought. Two companies, General Motors on the U.S. side and a consortium of firms on the German side, tried to bring into line the ideas of both countries. There was agreement at first that firepower should be the predominant feature of the tank. The second-rank criterion was, for the U.S. side, armor, and third was mobility. The Germans preferred the other way around. In addition to this conflict, both sides permanently and independently increased the requirements the outcome in 1967 was an enormous, complicated, heavy, and expensive prototype. The Germans mostly disliked the weight and the price (140 percent more than the Leopard-1) the Americans apparently criticized the fact that not only the gear unit/ transmission (*Renk*) but also the engine was German *(MTU)* and not of U.S. (Continental) origin. These conflicts could not be resolved, and finally both sides decided to end the cooperation in 1970.

1967-1979: When conflicts became evident in the U.S.-German cooperation, the German side initiated its own studies on improvements of the Leopard-1 (mainly with respect to fire power and mobility) as early as 1967. The engine and the gear unit/transmission were taken over from the MBT 70 development. A total of 17 prototypes of the Leopard-2 were built between 1970 and 1977, and series production started in 1979. However, there were some important developments in-between:

1972-1974: There was a short phase of British-German cooperation, aiming at a common successor to the Chieftain and to the Leopard-1. Some studies were concluded, and even

[1]See Overview 4 for a chronology.

Overview 4: Chronology of German Tank Production 1956-1992

1956	The *Bundeswehr* starts with M-48 tanks from the United States (U.S.). The German Ministry of Defense (MoD), together with the Ministry of Economics, initiates a study investigating the industrial potential of tank production.
1957	Government agreement with France to launch a national tank development with the purpose of selecting a standardized European tank.
1963	The French and German tank prototypes are tested. Performances are varied; conflicts arise over selection criteria and cooperation. Government agreement with the U.S. over common development of a standardized NATO tank MBT 70, in the same year.
1965	Germany delivers Leopard-1 to the German army, the first product from national tank production (with a British gun, though).
1967	U.S.-German MBT 70 prototype is presented, but no agreement is reached on the direction of further development. German firms provide studies on Leopard-1 improvements.
1970	U.S.-German tank cooperation ends after several attempts at compromise fail. Germany continues Leopard-1 improvements, with official support, and starts a series of prototypes for a successor "Leopard-2."
1972	German and British endeavors to replace Chieftain and Leopard-1 with a common tank. Common studies and developments are started.
1973	Tests of the prototypes do not convince the German side of British superiority over the Leopard-2. Cooperation ends in this year. Close contacts between the DoD of the U.S. and German MoD, aiming at standardization of tanks within NATO.
1974	Memorandum of Understanding aiming at selecting the superior national development as the standard tank or, at least, to attain standardization of key components to overcome problems of logistics.
1975	U.S. DoD invites German Leopard-2 prototype for a competition against the new U.S. main battle tank, i.e., the U.S. XM-1.
1976/ 1977	Competition takes place. Disputes over the results arise. The U.S. army decides against the Leopard-2.
1979	Serial production of Leopard-2 in Germany begins. The first tanks are delivered to the German army.
1982	The Netherlands purchase 445 of the Leopard-2.
1984	Switzerland decides in favor of the Leopard-2, and against the M-1. The 380 tanks are mainly built by licensed production in Switzerland.
1992	The last one of a total of 2,024 Leopard-2 tanks is delivered to the *Bundeswehr*. Sweden is considering the purchase of either Leopard-2 or M-1. No decision yet in the fall of 1992.

Source: Own archives.

two prototypes, with two guns each were built. However, there was no convincing advantage visible when comparing these prototypes with the new Leopard-2 developments, and the cooperation quickly expired.

1973/74-1977: Until 1974 a number of prototypes of the Leopard-2 had been developed and partially tested. As for the chassis, it differed in the type of steel used, in tracks, engines and the gear unit transmission. The turrets differed again regarding the type of steel used, the gun (105mm vs. 120mm), the optical appliances and the gun stabilization system. In 1973, closer contacts between the U.S. DoD and the German MoD had been established again, leading to a new cooperation (formulated in a Memorandum of Understanding in 1974). Again a standardization of MBTs within NATO was aimed at. The U.S. DoD officially invited West Germany to a competition test of the Leopard-2 and the new U.S. MBT at the beginning of 1975 ("to the consternation of the U.S. Army", as the IHT, 18/01/75, wrote). The development of the new XM-1 tank by Chrysler and General Motors was still in the design phase at that time. The U.S. government probably wanted to speed up their own developments by taking over suitable components from Germany, and the Germans in turn hoped to get a share of the U.S. market.

Two Leopard-2 prototypes were modified to meet the demands of the U.S. Army for higher protection, higher range, additional machine guns, etc. A 105mm caliber was chosen for the main gun, with the option to install the 120mm smoothbore gun that already had proven to be superior. Apparently there was severe resistance from the U.S.-tank industry to even take the German tank into consideration. But, quite surprisingly for most parties involved, politicians agreed upon a testing of the Leopard-2 against two U.S. prototypes in the fall of 1976: a GM version with a 1500hp-diesel engine and a Chrysler version with a turbine of the same performance. Parallel to this, the U.S. Army placed an order with a U.S. company (FMC) to investigate the possibilities of producing the Leopard-2 in the U.S. by means of licensed production. This study came to the conclusion that the production of the tank in the U.S. was generally feasible for all components. There was no objection on economic or technological grounds. However, there was a fierce dispute over the report of the test results of the tanks. The German representatives claimed that the Leopard-2 had met all requirements set by the U.S. Army, had proved to be superior to the XM-1 in many respects, and that the test report had been manipulated. German officials stated that the weights attached to diverse procedures were *ad hoc* altered, and that unrealistic testing was conducted. Furthermore, the 120mm gun had not been included in the test. (Years later, in 1986, after 3,000 M-1 tanks had been built, the U.S. also switched to the 120mm smoothbore gun, which was regarded by the German manufacturers as a late rehabilitation of their technology.) As a result of 1976-77 tests the U.S. Army rejected the Leopard-2 and also the inclusion of any of its components in the XM-1. There seems to have been great disappointment, even bitterness, on the German side over the course of these events. Again, cooperation ended abruptly. Two years later, in 1979, series production of the Leopard-2 in Germany started; in the U.S. the first M-1 from series production was delivered in 1981.

Hence, in the more than 20 years of German tank development, from 1956 to 1979, all efforts with regard to international cooperation failed. The concept of competition in developments, undertaken twice (the standardized tank and the Leopard-2/M-1 Abrams),

as well as the concept of joint development, also undertaken twice (MBT-70 and the British-German project) did not prove to be successful. Trials failed with all partners, the U.S. (twice), Great Britain and France. The reasons for the failures are claimed to lie in the highly emotional aspects and elements of national prestige which have always been associated with tank production.

1979-1992: Before the Leopard-2 took off in series production, however, there came a step of crucial importance from an industrial-policy point of view. The order of preparing series production (i.e., of working out the improvements of the last testing phases and integrating them into the new project design) was not directly given to the prime-contractor of the prototypes, *Krauss-Maffei*. The procurement office of MoD instead put the "independent" *Porsche* company in charge; *Porsche* had once initiated the Leopard-2 studies in 1967, and it had no interest in becoming the prime-contractor. Its task was to properly define the call for tenders for serial production so that firms could submit their tenders as potential prime contractors.[2] Three companies applied for this status, all with about equal chances: *Krauss-Maffei, Krupp MaK* and *Thyssen Henschel*. Hence, there was some competition among firms that also was transferred to the lower levels of contractors.

In the fall of 1979, the MoD decided that both *Krauss-Maffei* and *Krupp MaK* should act as prime contractors (for 55 percent and 45 percent of the total volume respectively). For the total requirement of 1,800 tanks, a first lot of 380 tanks should be produced until the end of 1981. Between 1982 to 1986, 300 tanks should be produced annually. In the mid-1980s, some additional orders were placed and Leopard-2 procurement by the *Bundeswehr* ended with a total amount of 2,135 tanks in April 1992.

In 1982, the Netherlands purchased 445 Leopard-2 (delivered between 1982 and 1986) and in 1984 Switzerland decided in favor of the Leopard-2 (against the M-1). Of the total 380 tanks procured, 35 were to be purchased from Germany, and the remaining 345 built on licenses to Switzerland. Today, Sweden is considering the purchase of either Leopard-2 or M-1, but no decision has been made yet (fall 1992).

[2]Most probably, the MoD simply tried to make use of the superior know-how of the *Porsche* experts, and enforce competition among the potential contractors. Basically, the procedure included the creation of the "transparency" of tank production, because *Porsche* was free to develop, out of the many offers of potential prime and subcontractors, an "ideal" production process for mass production.

APPENDIX D
The Regional Distribution

The regional concentration of defense production in Germany is quite strong, with roughly 5 percent going to *Schleswig-Holstein* (i.e., the north of Germany) and 45 percent going to *Bavaria* (i.e., the south of Germany). The regional structure of acquisition seems to follow, by and large, the structure of the respective industries as a whole, with shipbuilding contracts going to *Bremen*, and with aircraft and missiles being produced in *Bavaria*, which produces more than half of the German aircraft and aerospace output (Table 11).

The production of defense goods proper in Germany has again developed centers of concentration within the L_nder since 1956:

1. In *Bavaria* the major defense firms: *Messerschmitt-Bölkow-Blohm GmbH (MBB), Siemens AG, Motoren- und Turbinen-Union GmbH (MTU), Krauss-Maffei-Gruppe,* and *Maschinenfabrik Augsburg-Nürnberg* (*MAN*), are situated in the *München-Augsburg* region;

2. In *Baden-Württemberg* the major defense firms: *Dornier GmbH, MTU, Bodenseewerk Gerätetechnik,* and *Zahnradfabrik Friedrichshafen* (*ZF*), are situated around *Friedrichshafen* at Lake Constance;

3. In *Bremen* one finds *MBB, (Krupp) Atlas Elektronik,* the *Philips AG,* and the *Bremer Vulkan AG;*

4. In *Schleswig-Holstein* the major defense firms *MaK Systemgesellschaft GmbH, Howaldtswerke-Deutsche Werft AG,* and some plants of *Philips AG* and *Diehl-Gruppe* are located in the Kiel area.

Table 11: Regional Distribution of Defense Acquisition in Germany 1988: Selected Länder and Industries.

Land	Share of the Land in Total Acquisition[a] (Percent)	Major Defense-Related Industries of the Respective Land	Regional Distribution of the Industry[b] Percent)	Defense Share[c] (Percent)
Bayern	45.0	• Aircraft and Missiles	55.9	78.7
		• Mechanical Engineering	17.8	52.8
		• Electrical Engineering and Electronics	26.1	30.4
Baden-Wurttemberg	18.4	• Road Motor Vehicles	21.8	59.2
		• Electrical Engineering and Electronics	26.1	41.7
Nordrhein-Westfalen	12.2	• Mechanical Engineering	26.7	26.1
Bremen	6.9			
Schleswig-Holstein	5.0	• Shipbuilding	21.4	55.2
		• Shipbuilding	34.9	42.2

(a) For example: 45 percent of Germany's defense procurement goes to Bayern. — (b) For example: 55.9 percent of the German aircraft industry is located in Bayern (share of the respective Land in the industry's civilian and military production in Germany). — (c) For example: The Bavarian aircraft and missile industry has a defense share of 78.7 percent.

Source: Berger et al.

APPENDIX E
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